

Research Note 86-05

COST AND INFORMATION EFFECTIVENESS ANALYSIS: AN IMPROVED METHODOLOGY  
VOLUME II

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for

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20. ABSTRACT (Continue on reverse side if necessary and identify by block number) This report is the second of two volumes that present results of an effort to develop an improved methodology for the conduct of Cost and Information Effectiveness Analysis (CIEA). CIEA is a methodology for the evaluation of training device performance assessment capabilities (D-PACs). It is directed at the problem of determining when the worth of performance status information available from a D-PAC offsets the costs required to develop, operate, and maintain the capability. (Cont'd)		

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20. continued

This report presents a case study which illustrates application of CIEA to evaluate a series of D-PAC alternatives that provide performance status information on the gunnery proficiency of crews for the Combat Engineer Vehicle (CEV). CEV gunnery D-PAC alternatives were developed by combining members of a set of interactive video gunnery trainers for the CEV with different types of live fire exercises. The case study describes activities conducted in the four phases of the CIEA of CEV gunnery D-PACs: exploration of the D-PAC concept for CEV gunnery, development of the D-PAC concept for CEV gunnery, definition of the CEV gunnery D-PAC alternatives, and evaluation of CEV gunnery D-PAC alternatives. Activities of the last phase culminate with specification of the most cost-effective CEV gunnery D-PAC alternative.

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APPENDIX A

HIERARCHICAL ROLLBACK PROCEDURES  
FOR DERIVING NORMALIZED  
UTILITY AND IMPORTANCE SCORES

This appendix describes how utility values or importance weights are derived for items organized hierarchically. Figure A-1 illustrates the process for a hierarchy of hypothetical tasks, subtasks and skills. In Figure A-1, the ultimate objective is to compute a set of normalized utility scores for the skills. Utility scores will be derived based on ratings provided by SMEs. In CIEA, ratings are obtained using a rank and rate method in which SMEs first rank items in terms of utility or importance and then assign ratings that reflect the distance between items. Thus, the procedure calls for comparisons between items. When the number of items to be rated is large (greater than 10) it is difficult for SMEs to make comparisons between items. A hierarchy is used to organize the items into small groups within which comparison is relatively easy.

When a hierarchy is employed, the derivation of utilities requires that items in each level of the hierarchy be ranked and rated. The ratings at each level are scaled and the scaled values are "rolled back" through the hierarchy to yield utility scores for the terminal items in the hierarchy (skills in Figure A-1). Referring to Figure A-1, the normalized scores for the skills were derived by first rating items in each level of the hierarchy using a 0-100 scale. Next, the rated values were divided by 100. Then, values were multiplied across (or down) the hierarchy of tasks, subtasks, and skills until there was a single value for each skill. When all the skill values were determined, the set of all skill values was normalized by totaling the set of values and dividing each value by the total.

An alternative to the above process would be to normalize items at a given level to 1.0 and roll the normalized values through the hierarchy. The same normalized utility scores of the skills would result, but the summing of uncorrected utility scores and dividing each uncorrected score by the sum to yield a normalized score would not be required. Derivation of normalized scores at each level of the hierarchy would require that the ratings of a



set of items be summed and the rating of each item be divided by the resulting sum.<sup>†</sup> The sum of the normalized scores of a set of items would be one. When the normalized values of items are rolled back through the hierarchy, the resulting utility scores of the skills will sum to 1.0 also. Either procedure is equally effective. Choice of a procedure depends on user preference.

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<sup>†</sup>Note: When items are not organized hierarchically (e.g., there is less than 10 items) this same procedure is used to derive normalized scores. That is, the ratings are summed and the rating of each item is divided by the sum.



APPENDIX B

RESULTS OF CEV GUNNERY FRONT-END ANALYSIS (FEA)

## CEV GUNNERY TASKS

<u>Item</u>	<u>Task #</u>	<u>Title</u>
<u>CLUSTER 0. PERFORM PREPARE TO FIRE CHECKS</u>		
SL 1		
1.	C1001	Perform Driver prefire checks
2.	C1002	Perform Loader prefire checks
3.	C1002A	Perform Loader prefire checks for main gun
SL 2		
4.	C2001	Perform Gunner prefire checks
5.	C2002	Boresight the 7.62mm coax machine gun M-73
6.	C2003	Boresight the 7.62mm coax machine gun M-240
7.	C2004	Align the infinity sight with 7.62mm coax machine gun
8.	C2005	Zero the 7.62mm coax machine gun
9.	C2006	Boresight the 165mm M-235 main gun
SL 3		
10.	C3001	Perform tank commander (TC) prefire checks
11.	C3001A	Perform tank command (TC) prefire checks for main gun
12.	C3002	Boresight the caliber .50 M-85 machine gun
13.	C3003	Zero the caliber .50 M-85 machine gun
<u>CLUSTER 1. PERFORM AMMUNITION HANDLING</u>		
SL 1		
14.	C1101	Perform Loader misfire procedures for main gun
15.	C1102	Load/stow 165mm main gun ammunition
16.	C1103	Load the M-135 main gun
17.	C1104	Load/stow basic load ammunition
18.	C1105	Load the 7.62mm coax machine gun M-240
19.	C1106	Load the 7-62mm coax machine gun M-73
20.	C1107	Apply immediate action to reduce a stoppage in the 7.62mm coax machine gun
SL 2		
21.	C2101	Perform Gunner misfire procedures for main gun
SL 3		
22.	C3101	Load the caliber .50 M-85 machine gun
23.	C3102	Correct a stoppage of the caliber .50 M-85 machine gun using immediate action
<u>CLUSTER 2. OCCUPY FIRING POSITIONS</u>		
SL 1		
24.	C1201	Move into firing positions
SL 2		
25.	C2201	Prepare a circular range card
SL 3		
26.	C3201	Prepare range cards
27.	C3202	Select firing positions
28.	C3203	Direct movement into a firing position

CEV GUNNERY TASKS (Cont'd)

<u>Item</u>	<u>Task #</u>	<u>Title</u>
<u>CLUSTER 3. ENGAGE TARGETS</u>		
SL 1		
29.	C1301	Respond to a firing command as Loader or driver
30.	C1302	Detect and identify targets
31.	C1303	Operate CEV during 7.62mm coax machine gun target engagement
32.	C1304	Engage targets with 7.62mm coax machine gun as loader
SL 2		
33.	C2301	Respond to a firing command as Gunner
34.	C2302	Engage targets during limited visibility as Gunner
35.	C2303	Illuminate targets with searchlight as Gunner
36.	C2304	Determine target range
37.	C2305	Engage stationary targets with main gun using burst-on-target (BOT)
38.	C2306	Engage targets with main gun using rapid sequential round as Gunner
39.	C2307	Engage targets with 7.62mm coax machine gun as Gunner
SL 3		
40.	C3301	Issue a firing command
41.	C3302	Engage targets during limited visibility as TC
42.	C3303	Illuminate targets with search light as TC
43.	C3304	Engage targets with main gun using rapid sequential round as TC
44.	C3305	Engage ground targets with caliber .50 M-85 machine gun
45.	C3306	Engage aerial targets with caliber .50 M-85 machine gun
46.	C3307	Engage targets with 7.62mm coax machine gun as TC

12F CEV GUNNERY SKILL LIST

- 001 Recall location and function of switches, controls, and indicators.
- 002 Perform engine start and stop procedures.
- 003 Recall proper cleaning procedures for optical equipment.
- 004 Recall procedures for maintaining proper recoil oil fluid level.
- 005 Recall armament systems damage criteria.
- 006 Operate breechblock operating handle.
- 007 Recall ammunition serviceability criteria.
- 008 Recall that radios must be switched to OFF during engine start.
- 009 Recall firing circuit test procedures.
- 010 Recall ammunition safety cautions and warnings.
- 011 Recall main gun boresighting procedures.
- 012 Recall stowage location of fire control equipment.
- 013 Recall gun control check procedures.
- 014 Operate fire control equipment.
- 015 Install/dismount and stow direct fire sighting equipment.
- 016 Recall misfire procedures.
- 017 Recall that turret lock must be in locked position before removing/  
stowing ammunition in hull storage.
- 018 Recall that main gun should not be elevated above 178 miles (10 degrees)  
during loading.
- 019 Recall procedure for installing/removing inner and outer rounds  
in 165mm ready rack.
- 020 Drive CEV in daylight or dark.
- 021 Use military symbols.

12F CEV GUNNERY SKILL LIST (Cont'd)

- 022 Recall the four elements required to plat a target on a range card.
- 023 Identify potential targets.
- 024 Determine target azimuth.
- 025 Use binoculars and WORM formula to estimate range.
- 026 Recall that best source of range is a tank mounted range finder.
- 027 Determine quadrant elevation from Firing Table FT-165-A1.
- 028 Recall that range cards must be prepared for primary, alternate and supplemental firing positions.
- 029 Use map symbols.
- 030 Recall CEV capabilities and limitations.
- 031 Recall site selection criteria for CEV.
- 032 Recall that dangerous targets may require immediate engagement without regard to firing positions.
- 033 Use arm and hand signals to direct vehicle movement.
- 034 Recall elements of a fire command.
- 035 Operate CEV intercom system.
- 036 Operate main gun controls.
- 037 Recall best method of destruction for target types.
- 038 Recall techniques for target detection.
- 039 Recall that CEV's mounting searchlights do not fire while illuminating because of smoke and dust obscuration.
- 040 Recall that CEV's with searchlight mounted should not fire because of possible muzzle blast damage to searchlight.
- 041 Recall techniques for searchlight employment.
- 042 Recall that search light must not be used in overdrive more than once every five minutes.
- 043 Use appropriate sighting equipment for Black light.
- 044 Recall that CEV should move to alternate position as soon as possible.

12F CEV GUNNERY SKILL LIST (Cont'd)

- 045 Operate external radio communications.
- 046 Estimate 100 meter range using football field method.
- 047 Recall criteria for size of range correction in subsequent fire commands (25 meters for measured range, 50 meters for estimated range, doubled if miss is over 100 meters).
- 048 Recall boresighting procedure for Cal .50 machine gun.
- 049 Recall loading procedures for 7.62mm machine gun.
- 050 Recall loading procedures for Cal .50 machine gun.
- 051 Recall assembly/disassembly procedures for the Cal .50 M-85 machine gun.
- 052 Recall target engagement techniques for machine gun engagements.
- 053 Recall boresighting procedures for the 7.62mm coax machine gun.



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JOB DATA WORKSHEET  
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JOB TITLE 12 F		DOS CEV Gunnery Tasks			
DUTY CODE 0. Perform Prepare to Fire Checks		LEVEL SL1			
ITEM CODE	TASK, ELEMENTS	17. INITIATING CUES	18. CONDITIONS	19. STANDARDS	20. NOTES
C1002	Perform Loader prefire checks J.P.M.	Combat or training firing mission ordered.	As loader in a CEV crew During daylight, prior to initiating combat mission or training firing.	All checks completed in coordination with other crew members within 5 minutes.	001 Recall location as functions of switches, controls, and indicate
1.	Read the replenisher indicator type and service as required	IC announces "PREPARE TO FIRE".			004 Recall procedures maintaining proper rec oil fluid level.
2.	Inspect main gun tube		Supervision available TM 9-2350-222-10-1 is available	All cautions and warnings observes.	005 Recall ammunition damage criteria
3.	Check 7.62mm MG mount				006 Operate breechblock operating handle.
4.	Inspect all turret stowed ammunition for proper stowage, complete load and serviceability				007 Recall ammunition serviceability criteria
5.	On IC's command, install/remove firing circuit tester				009 Recall firing circuit test procedures
6.	Assist in testing, firing circuit for main gun and 7.62mm MG				010 Recall ammunition safety cautions and warnings
7.	On IC's command, assist in testing gun controls				011 Recall main gun be sighting procedures
8.	Inspect all hull stowed ammunition for proper stowage, complete load and serviceability after coordinating with gunner to insure turret is locked				012 Recall storage location



JOB DATA WORKSHEET  
(TRADOC Pam 350-30)

JOB TITLE 12F		DOS CEV GUNNERY TASKS			
DUTY CODE		LEVEL			
ITEM CODE	TASK, ELEMENTS J.P.M.	17. INITIATING CUES	18. CONDITIONS	19. STANDARDS	20. NOTES
C1002A	Perform Loader prefire checks for main gun.	Combat or training firing mission ordered	As the loader in a CEV crew	All checks completed in coordination with other crew members within 5 minutes.	001 Recall location and function of switch, controls, and indicators.
1.	Read the replenisher indicator tape and service as required	TC announces "PREPARE TO FIRE"	In a stationary CEV		
2.	Inspect main gun tube and chamber, check breech spring tension		During daylight or night		
3.	Inspect ammunition for condition, proper stowage, and complete load		Prior to initiating combat	Observe safety warnings	004 Recall procedures maintaining proper recall fluid level
4.	In TC's command, install/remove firing circuit tester		Mission or training firing supervision available		005 Recall armament system damage criteria
5.	Assist in testing firing circuit		TN 9-2150-222-10-1 is available		006 Operate breechblock operating handle
6.	Assist in checking gun controls				007 Recall ammunition serviceability criteria
7.	In TC's command, assist Gunner in bore-sighting main gun				008 Recall firing circuit procedures
8.	Install, remove, and stow breech bore-sight				009 Recall firing circuit procedures
9.	Report "LOADER READY" to TC.				010 Recall ammunition safety warnings and cautions
					011 Recall main gun bore-sighting procedures
					012 Recall stowage location of fire control equipment
					013 Recall gun control check procedures

**JOB DATA WORKSHEET**  
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JOB TITLE		DOS CEV Gunnery Tasks						
12F		LEVEL SL2						
DUTY CODE	0. Perform Prepare to Fire Checks	17. INITIATING CUES	18. CONDITIONS	19. STANDARDS	20. NOTES			
ITEM CODE	16. TASK, ELEMENTS J.P.M.	17. INITIATING CUES	18. CONDITIONS	19. STANDARDS	20. NOTES			
C2001	Prepare Gunner Prefire Checks	Combat or training firing mission ordered	As the Gunner in a CEV crew, in a stationary CEV during daylight or night	All checks completed in coordination with other crew members within 5 minutes	001 Recall location a function of switches, controls, and indicator			
1.	Observe Loader's check of replenisher indicator tape	TC announces "PREPARE TO FIRE"	Prior to initiating combat or training firing	Observe safety warnings	003 Recall proper cde procedures for optics equipment			
2.	Install, clean and inspect direct fire sights		Supervision available TM 9-2350-222-10-1 is present		009 Recall firing cde test procedures			
3.	Check operation of ballistic shield				013 Recall gun contric check procedures			
4.	Check instrument light and control				014 Operate fire cont equipment			
5.	On IC's command, test firing control circuit in coordination with IC and Loader	/			011 Recall maingun bo sighting procedures			
6.	On IC's command, check gun controls, power pack, oil level and equilibrator hydraulic fluid level, in coordination with Loader				015 Install/dismount and stow direct fire sighting equipment			
7.	Check azimuth indicator for accuracy				C2006 Boresight the 165mm M-135 maingun			
8.	Check elevation quadrant							
9.	Boresight maingun, periscope and telescope in coordination with Loader							

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JOB TITLE		DOS		CEV Gunnery Tasks	
12F		LEVEL		SL2	
DUTY CODE					
O. Perform Prepare to Fire Checks					
ITEM CODE	TASK, ELEMENTS	17. INITIATING CUES	18. CONDITIONS	19. STANDARDS	20. NOTES
C2002	16. TASK, ELEMENTS J.P.M.	TC directs after maingun is borsighted	As Gunner in a CFV crew, in a CFV with 7.62mm MG (M-73) mounted and sighting equipment present in daylight	An accurate relationship between the gunner's sight reticle, and the 7.62mm gun bore is established at a 600 meter aiming point	001 Recall location & function of switches, controls, and indicator
1.	lay borsight maingun on the aiming point		Vehicle is parked on level terrain, maingun has been borsighted		012 Recall stowage loc of fire control equip
2.	Set elevation/traverse power switch to OFF and verify that gun is unloaded and safety in "S" (safe) position		A distinct aiming point approximately 600 meters away is clearly visible		014 Operate fire control equipment
3.	Loosen three set screws on outside collar		Necessary tools and M17A1 binoculars are available		015 Install/dismount stow direct fire sight equipment
4.	Remove electrical lead from receiver and remove receiver from jacket assembly		Assistance is available		053 Recall borsight procedures for the 7.62mm machine gun
5.	Loosen mounting screws, jam and locking nuts for vertical and horizontal adjustments				
6.	Focus on aiming point with right side of M17A1 binoculars through bore and align bore with aiming point				
7.	Tighten mounting screws, locking and jam nuts, and reassemble receiver. Reconstruct electrical lead				
8.	Tighten collar set screws				

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JOB TITLE		DOS		CEV Gunnery Tasks		LEVEL		SL2		STANDARDS		NOTES	
DUTY CODE		12F		O. Perform Prepare to Fire Checks		17. INITIATING CUES		18. CONDITIONS		19.		20.	
ITEM CODE	TASK, ELEMENTS J.P.M.	17. INITIATING CUES		18. CONDITIONS		19.		20.		STANDARDS		NOTES	
C-0003	Boresight the 7.62mm coax M.C. M-240	TC directs after maingun is boresighted		As Gunner in a CEV Crew, in a CEV, with 7.62mm MG (M-240) mounted and sighting equipment present in daylight vehicle is parked on level terrain, maingun has been boresighted.		An accurate relationship between gunner's sight reticle and the 7.62mm MG bore is established at a 600 meter aiming point		001 Recall location and function of switches, controls and indicator		012 Recall stowage location of fire control equipment		014 Operate fire control equipment	
1.	Law boresighted maingun on the aiming point												
2.	Set elevation/traverse power switch to OFF and verify that gun is unfused, bolt is forward												
3.	Remove buffer, driver spring, mounting pin, slide rod and bolt assembly												
4.	Loosen mounting nut and tighten to 1/4 turn past touching washer												
5.	Focus on aiming point with sight side of M/AL binoculars through bore and align fore with aiming point												
6.	Tighten mounting nut and re-check bore alignment												
7.	Reassemble machine gun												
8.	Return bolt to forward position												
9.	Stow tools and equipment												

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JOB TITLE		DOS				CEV Gunnery Tasks		SL2		20. NOTES	
DUTY CODE		LEVEL		18. CONDITIONS		19. STANDARDS		20. NOTES		20. NOTES	
O. Perform Prepare to Fire Checks											
ITEM CODE	16.	TASK, ELEMENTS	17. INITIATING CUES	18. CONDITIONS	19. STANDARDS	20. NOTES					
C2005		Zero the 7.62mm coax N.G.	Zeroing has been directed	As Gunner in a CEV crew, in a CEV, parked on level terrain, in daylight, 7.62mm coax MG is mounted and boresighted with 100 rounds, available	Adjust the center of burst to fall within the infinity sight picture of a 600 meter aiming point	001 Recall location at function of switches, controls and indicators					
1.		Low gun on 600 meter aiming point using M2C periscope				010 Recall ammunition safety cautions and warnings					
2.		Adjust light intensity of infinity sight reticle		A clearly defined target approximately 600 meters away has been designated		012 Recall stowage location of fire control equipment					
3.		Load and clear the gun and fire a 20 to 25 round burst				014 Operate fire control equipment					
4.		Without disturbing gun lay, use infinity sight boresight knobs to center strike area in the reticle				015 Install/dismount stow direct fire sight equipment					
5.		Relate gun to aiming point and fire another 20-25 round burst				049 Recall loading procedures for 7.62mm machine gun					
6.		Repeat process until center of burst is inside sight reticle				053 Recall boresighting procedures for the 7.62mm coax machine gun					
						C2002 Boresight the 7.62mm MG (N-73)					
						C2003 Boresight the 7.62mm MG (N-240)					

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JOB TITLE 12F		DOS CEV Gunnery Tasks			
DUTY CODE 0. Perform Prepare to Fire Checks		LEVEL SL2			
ITEM CODE	TASK, ELEMENTS J.P.M.	17. INITIATING CUES	18. CONDITIONS	19. STANDARDS	20. NOTES
C2000	16. Prepare to fire drill is under way	17. Initiating cues	18. Conditions	19. Standards	20. Notes
1.	16.1. Set elevation/traverse power switch and maingun switch to OFF, and master battery switch to ON. Unlock turret traverse lock. Depress gun manually to remove excess play	17.1. Prepare to fire drill is under way	18.1. As Gunner in CEV crew, in a CEV preparing for combat or for a firing exercise vehicle parked on level terrain, sighting equipment is installed	19.1. An accurate relationship between the gunner's sight reticles and the maingun bore is established at a 600 meter aiming point	20.1. Recall location function of switches, controls and indicators
2.	16.2. Direct leader to secure bore-sight cord over muzzle witness lines with tape	17.2. Direct leader to secure bore-sight cord over muzzle witness lines with tape	18.2. A distinct aiming point, approximately 600 meters away is visible	19.2. Bore-sight, bore-sight cord, tape and MVAI binoculars are available	20.2. Recall stowage location of fire control equipment
3.	16.3. Jack breech open and install breech boresight	17.3. Jack breech open and install breech boresight	18.3. Assistance is available	19.3. Adjust M32C only in darkness to prevent light damage	20.3. Install/dismount stow direct fire sight equipment
4.	16.4. Align bore with right angle corner of target using manual elevation and traverse	17.4. Align bore with right angle corner of target using manual elevation and traverse	18.4. Select HEP reticle in 105F telescope and adjust telescope reticle to aiming point and verify bore on aiming point	19.4. Install and adjust visible light bore reticle for M32C. Adjust only in darkness	
5.	16.5. Select HEP reticle in 105F telescope and adjust telescope reticle to aiming point and verify bore on aiming point	17.5. Select HEP reticle in 105F telescope and adjust telescope reticle to aiming point and verify bore on aiming point	18.5. Install and adjust visible light bore reticle for M32C. Adjust only in darkness		
6.	16.6. Install and adjust visible light bore reticle for M32C. Adjust only in darkness	17.6. Install and adjust visible light bore reticle for M32C. Adjust only in darkness			

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JOB TITLE 12F		DOS CEV Gunnery Tasks			
DUTY CODE		LEVEL SL2			
ITEM CODE	0. Perform Prepare to Fire Checks	17. INITIATING CUES	18. CONDITIONS	19. STANDARDS	20. NOTES
C3001	16. TASK, ELEMENTS J.P.M. Perform Tank Commander (TC) Prepare checks	Combat or training firing mission is ordered	As the TC in a CEV crew in a stationary CEV During daylight or night Prior to initiating com- bat or training firing	All checks completed in coordination with other crew members, within 5 minutes (boresighting takes additional time)	001 Recall location a function of switches. controls and indicato
1.	Command "PREPARE TO FIRE"				003 Recall proper cle
2.	Switch radios to OFF during engine start		TM 9-2350-222-10-1 is present	Observe safety warnings	ing procedures for op
3.	Clean turret exterior lens and vision devices			Supervise completion of other crew members' checks	008 Recall that radio must be switched to 0 during engine start
4.	Check M34 or M36 periscope				009 Recall firing cir
5.	Command "CHECK FIRING SWITCHES"				test procedures
6.	Test firing control circuit in coordination with loader and gunner				013 Recall gun contro check procedures
7.	Command "CHECK GUN CONTROLS"				048 Recall boresighti procedures for Cal.50 machine gun
8.	Check run controls for power elevation and traverse				050 Recall loading pr cedures for Cal.50 machine gun
9.	Command "CHECK FIRE CONTROL"				C3002 Boresight the Cal.50 M8's MC
10.	Check operation of Cal.50 gun mount and controls				
11.	Check firing operation of Cal.50 MC				

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JOB DATA WORKSHEET (TRADOC Pam 350-30)				Page 2 of 3 DATE	
JOB TITLE		DOS		CEV Gunnerv Tasks	
12F		LEVEL		SL3	
0. Perform Prepare to Fire Checks					
ITEM CODE	TASK, ELEMENTS J.P.M.	17. INITIATING CUES	18. CONDITIONS	19. STANDARDS	20. NOTES
C3002	Bore sight the cal .50 M-85 MG	Cal .50 MG is being installed, combat or training firing mission is ordered, or prepare to fire drill is being performed	As TC in a CEV crew in a CEV with M85 MG mounted, and sighting equipment present, in daylight vehicle is parked on level terrain	An accurate relationship is established between the M85 bore and the M34 and M36 sight reticles at a 500 meter aiming point	001 Recall location, function of switches, controls and indicators
1.	Remove periscope body				012 Recall stowage location of fire control equipment
2.	Place MG in "S" (safe) position and insure that gun is unloaded				014 Operate fire control equipment
3.	Remove back plate, buffer group, rear assembly, and bolt assembly		A distinct aiming point, approximately 500 meters away, has been identified		015 Install/dismount stow direct fire sight equipment
4.	Align the center of the barrel with aiming point by manually positioning the capola and engage the azimuth lock				046 Recall boresight procedure for Cal .50 machine gun
5.	Install the M34 periscope and adjust elevation and traverse until 500 meter aiming point is aligned with aiming point. Rotate slip scale on elevation and deflection knobs to read 4 and 4				051 Recall assembly/disassembly procedure the Cal .50 M85 machine gun
6.	Remove M34 and install M36 periscope				
7.	Adjust elevation and traverse until 500 meter aiming point is aligned with aiming point. Rotate slip scales on elevation knobs to read 4 and 4				

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JOB DATA WORKSHEET (TRADOC Pam 350-30)						Page 13 of 17 DATE
JOB TITLE 12F		DOS		CEV Gunnery Tasks		
DUTY CODE		LEVEL		SL3		
O. Perform Prepare to Fire Checks		17. INITIATING CUES		18. CONDITIONS		
ITEM CODE	16. TASK, ELEMENTS J.F.M.	17. INITIATING CUES	18. CONDITIONS	19. STANDARDS	20. NOTES	
C3003	Zero the cal .50 M-85 MG	Zeroing has been directed	As TC in a CEV crew, in a CEV with M85 mounted and boresighted	Adjust burst to 500 meter aiming point for both periscopes	001 Recall location a function of switches, controls, and indicat	
1.	For M36 or M36 periscope sight to lay gun on 500 meter aiming point by traversing and elevating camera		100 rounds ammunition available, parked on level terrain, in daylight		010 Recall ammunition safety cautions and w	
2.	Load and charge the MG and fire a 10 to 20 round burst		500 meter target has been designated		ings	
3.	Check lay of the gun after firing and readjust to aiming point if necessary			012 Recall storage lo of fire control equip		
4.	Without moving gun lay, adjust periscope deflection and elevation until 500 meter aiming point is at center of target strike area			014 Operate fire cont equipment		
5.	Fire another 10 to 20 round burst to confirm zero			015 Install/dismount stow direct fire siph equipment		
6.	Repeat procedure for other periscope			048 Recall boresight procedure for cal .50 machine gun		
7.	Verify nonballistic reticle aiming point of M36 IR periscope by firing a burst at same target at dusk or with search light illumination			050 Recall loading pr cedures for cal .50 machine gun		
				C3002 Bore sight the c .50 M85 MG		
				C3102 Load the cal .50 M85 MG		

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JOB DATA WORKSHEET (TRADOC Pam 350-30)						Page 16 of P DATE
JOB TITLE 12F		DOS				
DUTY CODE		CEV Gunnery Tasks				
1. Perform Ammunition Handling		LEVEL SLI				
ITEM CODE	TASK, ELEMENTS J.P.M.	17. INITIATING CUES	18. CONDITIONS	19. STANDARDS	20. NOTES	
C1103	Load the M-135 maingun	Upon order of the TC or gunner	As the loader in a CEV crew, given a CEV with ammunition stored	Round is loaded and properly seated, without violation of safety restrictions, within 5 seconds	006 Operate breechblock operating handle	
1.	Set maingun safety switch to SAFE		Daylight or Dark, under all weather conditions.		010 Recall ammunition safety cautions and warnings	
2.	Open breechblock fully, and check that chamber is empty and free of debris after each round		in combat or during training firing		011 Recall misfire procedures	
3.	Return operating handle to loader position				017 Recall that turret lock must be in locked position before removing ammunition from full storage	
4.	Remove round from ready rack, place projectile on breechblock rollers, insert and seat round				018 Recall that gun should not be elevated above 45° (10 degrees) during loading	
5.	Detach and remove the handle from the round				019 Recall procedures installing/removing in and out rounds in the ready rack	
6.	Close the breechblock				0101 Perform misfire procedures for maingun	
7.	Return maingun safety switch to FIRE, and remain clear of the recoil path				0102 Load/store 165mm gun ammunition	
8.	Announce "Up"					

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JOB TITLE		JOB DATA WORKSHEET (TRADOC Pam 350-30)				Page 20 of DATE	
DUTY CODE		DOS		CEV Gunnery Tasks			
1. Perform Ammunition Handling		LEVEL		SLI			
ITEM CODE	TASK, ELEMENTS J.F.N.	17. INITIATING CUES	18. CONDITIONS	19. STANDARDS	20. NOTES		
C1107	Apply immediate action to 7.62mm MG	Round fails to fire while firing the 7.62mm coax MG	As loader in a CEV crew in a CEV, while firing the 7.62mm coax MG, a stoppage occurs	Within 10 seconds, apply immediate action and re-engage target	001 Recall location and function of switches, controls, and indicator		
1.	For a cold gun! Wait 5 seconds			All safety warnings and cautions are observed	010 Recall ammunition safety cautions and warnings		
2.	Pull back charging handle and press trigger				016 Recall misfire procedures		
3.	If gun stops again, wait 5 seconds and unload, set safety to "P", pull charger handle to rear, and let charger handle go forward slowly while pressing trigger						
4.	Load gun and try to fire manually. If gun stops again, wait 5 seconds, unload and troubleshoot gun				C1105 Load the 7.62mm coax MG (N-240)		
5.	For a hot gun: wait 5 seconds				C1106 Load the 7.62mm coax MG (N-73)		
6.	Pull back charger handle, and press trigger.						
7.	If gun stops again, wait 5 seconds and unload with 5 seconds						
	If gun cannot be unloaded within 5 seconds, pull charging handle to the rear, close cover, and						

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JOB TITLE 12F

DOS

## CEV Gunnery Tasks

DUTY CODE

**LEVEL**

## 1. Perform Ammunition Handling

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16.	TASK, ELEMENTS	J. P. M.

NOTES

Keep gun pointed at target for 15 minutes, to cool

## 18. CONDITIONS

19. STANDARDS

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JOB TITLE 12F		DOS CEV Gunnery Tasks			
DUTY CODE		LEVEL SL2			
ITEM CODE	16. TASK, ELEMENTS J.P.M.	17. INITIATING CUES	18. CONDITIONS	19. STANDARDS	20. NOTES
C2101	Perform gunner misfire procedures for maingun	Round fails to fire during a fire mission	As Gunner in a CEV During a fire mission with maingun loaded	Performance measures accomplished in sequence without error, from memory in a safe manner	001 Recall location function of switches controls and indicators
1.	Announce "MISFIRE"		Supervision is available		010 Recall ammunition
2.	Keep muzzle trained on target			Actions accomplished on a vehicle evacuated within 4 minutes of last attempt to fire for at least two hours	016 Recall misfire procedures
3.	Keep personnel clear of muzzle and recoil path				
4.	Attempt to fire by operating in sequence gunner and TC hand control trigger, manual elevation firing button and the manual firing handle			Unfired round is removed from vehicle and placed a safe distance from all personnel	
5.	Wait 2 minutes after last attempt to fire, and then direct loader to unload round				
6.	If the weapon is too hot to unload, close breech, wait 2 more minutes, then direct loader to try to unload again				
7.	If still too hot, close breech, inform TC and evacuate CEV on order for two hours, or until gun is cooled				
8.	If round does not "cook off" and after weapon has cooled,				

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JOB TITLE		DOS		CEV Gunnery Tasks		Page 23 of ___ Page	
JOB DATA WORKSHEET (TRADOC Pam 350-30)						DATE	
JOB CODE		LEVEL		SL3			
1. Perform Ammunition Handling							
ITEM CODE	TASK, ELEMENTS J.P.M.	17. INITIATING CUES	18. CONDITIONS	19. STANDARDS	20. NOTES		
C3102	Correct a stoppage of the cal .50 M-85 PG using immediate action	Round fails to fire while firing M-85 PG	As TC in a CPU crew in a CEV, while firing cal .50 M-85 PG, a stoppage occurs	Within 10 seconds, apply immediate action and re-engage target	001 Recall location and function of switches, controls and indicators		
1.	Keep weapon trained on target; if weapon is cold:			All safety warnings and precautions are observed	010 Recall ammunition safety cautions and warnings		
2.	Wait 5 seconds for possible hangfire				016 Recall misfire procedures		
3.	Retract bolt and press trigger						
4.	If weapon fails to fire, wait another 5 seconds and retract bolt						
5.	Open cover assembly and remove ammunition						
6.	Determine cause of stoppage, correct, reload, and continue engagement						
7.	If weapon is hot, wait 5 seconds for possible hangfire						
8.	Detract the bolt and press trigger						
9.	If gun does not fire, open cover assembly and unload						

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1. Firing Positions		DOS		CEV Gunnery Tasks		LEVEL		SL3	
2. Gun	3. Gunner	4. Gunner's Position	5. Gunner's Position	6. Gunner's Position	7. Gunner's Position	8. Conditions	9. Standards	10. Notes	11. Notes
1.		Prepare range card	Firing Position is occupied			As commander of a CEV crew given a CEV at a firing position, paper, pencil, straight edge, and binoculars, in daylight, in combat, or during training or firing/exercise	Target area is accurately sketched, target identification range, or azimuth and quadrant elevation is accurately plotted, for effective engagement during limited visibility selected reference point is common to gunner's R.P.	014 Operate fire control equipment	021 Use military symbols
2.		Identify reference point in area of fire				Sector of responsibility is provided		022 Recall the four elements required to plot target on range card	023 Identify potential targets
3.		Deflection is based on azimuth indicator readings with zero on reference point				TC may be assisted by Gunner		024 Determine target range	025 Use binoculars and mil formula to estimate range
4.		Reference point is plotted on range card						026 Recall that best source of range is a tank mounted range finder	027 Determine quadrant elevation for gun from Table FT-165-A1
5.		Identify targets on range card						028 Recall that range cards must be prepared for primary, alternate and supplemental positions	029 Use map symbols
6.		Record deflection							
7.		Record range							
8.		Record quadrant elevation for gun							
9.		Record quadrant elevation for search light							
10.		Plot CEV's sector of responsibility or area of fire							

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## 2. Occupy Firing Positions

## 18. CONDITIONS

10

## 17. INITIATING CUES

## 18. CONDITIONS

9.

## STANDARDS

NOTES

20. NOTES

C3-01

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DOS

LEVEL	SL3
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## CONDITIONS



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B TITLE		12F		DOS		CEV Gunnery Tasks	
TY CODE		3. Engage Targets		LEVEL		SL1	
ITEM CODE	TASK, ELEMENTS J.P.M.	17. INITIATING CUES	18. CONDITIONS	19. STANDARDS	20. NOTES		
1101	Respond to a fire command (as loader or driver)	TC announces "GUNNER-HEP"	As loader or driver in a CEV crew, given a CEV in combat or during a firing exercise, during daylight target is visible	Necessary actions in response to fire command elements are taken rapidly and accurately	001 Recall location of switches, controls and indicators 006 Operate breechblock operating handle 010 Recall ammunition safety cautions, and warn- ings 016 Recall misfire pro- cedures 020 Drive CEV in daylight or dark 034 Recall elements of fire command 035 Operate CEV intercom system 038 Recall techniques for target detection C1302 Detect and identify targets C1201 Move into firing position C1101 Perform misfire		
1.	(DRIVER) If moving, selects firing position, and position with full oriented towards target		Main gun is bore sighted and zeroed	Observe performance			
2.	Observes for round bursts, reports sightings						
3.	(LOADER) Check turret ring and insure it is not locked						
4.	Load main gun, check safety switch is set to FIRE, stand clear, and announce "Up"						
5.	Prepare to reload						



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DOS  
CEV Gunnery Tasks

LEVEL	SL1, 2 and 3
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JOB TITLE		12F		DOS		CEV Gunnery Tasks		SL1	
DUTY CODE		3. Target Engagement		LEVEL		STANDARDS		NOTES	
ITEM CODE	TASK, ELEMENTS	17. INITIATING CUES	18. CONDITIONS	19. STANDARDS	20. NOTES				
C1304	16. J.P.M. Engage targets with 7.62mm coax MG (as leader)	TC announces "GUNNER-COAX"	As leader in a CEV crew in a CEV, in combat or during a firing exercise	Coaxgun is serviced to allow engagement	010 Recall ammunition safety cautions and warnings				
1.	Check that turret ring is not obstructed		Coax is loaded		016 Recall misfire procedures				
2.	Check that weapon is charged and ready and safety is in the FIRE position				034 Recall elements of a fire command				
3.	Ensure that there is 3 to 4 inches of slack between ammunition box and receiver of gun before and during firing				035 Operate CEV intercom system				
4.	Announce "Up"				049 Recall loading procedures for 7.62mm machine gun				
5.	Upon command "CEASE FIRE" place weapon in SAFE position				C1105 Load the 7.62mm coax MG (M-240)				
					C1106 Load the 7.62mm coax MG (M-73)				
					C1107 Apply immediate action to reduce a stoppage in the 7.62mm MG				
					C1301 Respond to a firing command				

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TITLE 12F

DOS

CEV Gunnery Tasks

LEVEL SL2

ITEM CODE	TASK, ELEMENTS J.P.M.	17. INITIATING CUES	18. CONDITIONS	19. STANDARDS	20. NOTES
16.	Respond to a firing command (as gunner)	TC announces "GUNNER-HEP"	As gunner in a CEV crew in a CV in combat or during a firing exercise	Necessary actions, in response to fire command element are taken rapidly and accurately	001 Recall location of switches, controls, and indicators
1.	Insure turret power is ON		During daylight, target is visible		014 Operate fire control equipment
2.	Turn on maingun firing switch		Maingun has been bore-sighted and zeroed		016 Recall misfire procedures
3.	Look through sights to locate target				023 Identify potential targets
4.	If directed "TRAVERSE", traverse gun in direction given until TC announces "STILL"				034 Recall elements of a fire command
5.	Slow traverse until TC announces "ON". When target is visually acquired announce "IDENTIFIED"				035 Operate CIV intercom system
6.	When TC announces range, elevate gun to obtain correct sight picture and alignment				036 Operate maingun controls
7.	When TC directs "FIRE", announce "ON THE WAY" wait one second, and press firing trigger				037 Recall best method of destruction for target types
8.	Observe for round burst				038 Recall techniques for target detection
9.	Continue engagement as directed until fire mission is terminated by TC				CI 302 Detect and identify targets

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3. Target Engagement		DOS		CEV Gunnery Tasks		LEVEL		SL2		19. STANDARDS		20. NOTES	
ITEM CODE	TASK, ELEMENTS J.P.M.	17. INITIATING CUES	18. CONDITIONS	19. STANDARDS	20. NOTES								
2302	16. Image targets during limited visibility (as gunner)	Fire mission is initiated during limited visibility by initial TC command of "GUNNER-REP"	As gunner in a CEV crew in a CEV, during period of limited visibility or darkness, in combat or during firing or training exercise	Completes necessary actions in response to fire command to achieve target hit within 10 seconds	001 Recall location and function of switches, controls and indicators								
1.	Turn on turret power and maingun switch				014 Operate fire control equipment								
2.	Traverse to announced deflection, read back deflection		Maingun is boresighted and zeroed		016 Recall misfire procedures								
3.	Set quadrant elevation on quadrant and zero bubble, read back quadrant elevation		Range card has been prepared		023 Identify potential targets								
4.	After command "FIRE" announce "ON THE WAY", wait one second, and press firing trigger				024 Determine target azimuth								
5.	Observe for burst				034 Recall elements of a fire command								
6.	If required, adjust azimuth and elevation from subsequent fire commands until fire mission is terminated				035 Operate CEV intercom system								
7.	If target is illuminated, continue engagement with direct fire sights until engagement is terminated				036 Operate maingun controls								
					037 Recall best method of destruction for target types								
					02301 Respond to a firing command								

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3 TITLE 12F

TY CODE

3. Target Engagement

ITEM  
CODE  
302

16. TASK, ELEMENTS  
J.P.M.

17. INITIATING CUES

18. CONDITIONS

19. STANDARDS

20. NOTES

CEV Gunnery Tasks

SL2

CE201 Prepare a  
circular range card

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FORM 100-1 (REVISION 1) 10-60

Print this worksheet at the time you receive

FORM 100-1 (REVISION 1) 10-60



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JOB TITLE 12F		DOS		CEV Gunnery Tasks		Page 35 of 35 DATE	
DUTY CODE		LEVEL		SL2			
ITEM CODE	TASK, ELEMENTS J.P.M.	17. INITIATING CUES	18. CONDITIONS	19. STANDARDS	20. NOTES		
C2303	1. Illuminate targets with searchlight (as gunner)	TC commands "GUNNER-WHITE LIGHT" (or "BLACK-LIGHT")	As gunner in a CEV crew, in a CEV in combat or during a firing or training exercise, during a period of darkness	All elements of firing command are properly followed without error. Designated target is illuminated	001 Recall location and function of switches, controls and indicators		
	2. Turn on turret power				014 Operate fire control equipment		
	3. Traverse to announced deflection, read back deflection		Searchlight is mounted and bore-sighted		023 Identify potential targets		
	4. Set quadrant elevation on quadrant, zero bubble, read back quadrant elevation		Range card has been prepared		034 Recall elements of a fire command		
	5. After TC announces "ILLUMINATE" move the searchlight beam on to the center of the target area				035 Operate CEV intercom system		
	6. Traverse, elevate, or depress gun as directed by TC				036 Operate maingun controls		
					038 Recall techniques for target detection		
					041 Recall techniques for searchlight employment		
					043 Use appropriate sighting equipment for black light		
					C2301 Respond to a firing command		

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### 3. Target Engagement

16. TASK, ELEMENTS  
J. P. M.

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J. P. M.

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## 17. INITIATING CUES

## 18. CONDITIONS

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## STANDARDS

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CC2201 Prepare a circular range card

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JOB TITLE 12F		DOS		CEV Gunnery Tasks	
UTY CODE		LEVEL		SL2/3	
3. Target Engagement					
ITEM CODE	TASK, ELEMENTS J.P.N.	17. INITIATING CUES	18. CONDITIONS	19. STANDARDS	20. NOTES
C2304	Determine target range	A new target is designated or identified, for immediate engagement or for data entry on range card	As TC or runner in a CEV crew, in a CEV in combat or during a firing or training exercise	Determine range of targets within 1000 meters to nearest 50 meters	Recall location and function of switches, controls and indicators
1.	If available, obtain target range from a vehicle with ranging capability or		Binoculars are available	For hasty estimation (football field method) to nearest 100 meters	014 Operate fire control equipment
2.	Set reticle selector to mile scale on 10x1 telescope		Vehicles equipped with a ranging capability (such as M-60 tank) may be available for assistance		015 Install/dismount and store direct fire sighting equipment
3.	Measure target height in miles				
4.	Estimate target height in meters		TC makes final range determination		025 Use binoculars and WORM formula to estimate range
5.	Apply WORM formula to estimate range or				026 Recall that best source of range is a tank-mounted range finder
6.	To estimate range of targets with known horizontal width, use binocular mil scale and apply WORM formula or				038 Recall techniques for target detection
7.	Range with .50 cal M6 by placing round on target and reading range from M46 ballistic reticle or				045 Operate external radio communications
8.	For immediate fire without dislodging position, cut to 500 meters, estimate 100 segments using football field length as base. Over 500 meters, select halfway				046 Estimate 100 meter range using football field method

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## DOS CEV Gunnery Tasks

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### 3. Target Engagement

LEVEL SL2/3

ITEM	TASK, ELEMENTS
CODE	16. J.P.M.

TASK, ELEMENTS  
J.P.M.

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## 18. CONDITIONS

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## NOTES

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OB TITLE		DOS		CEV Gunnery Tasks	
12F		LEVEL		SL2/3	
12F		LEVEL		SL2/3	
3. Target Engagement					
ITEM CODE	TASK, ELEMENTS J.P.N.	17. INITIATING CUES	18. CONDITIONS	19. STANDARDS	20. NOTES
C2305	Engage stationary targets with maingun using Burst-on-Target (BOT) Note: Procedures for either runner or TC, whichever senses burst	Target engagement is under way, first round misses, burst is sensed by runner or by TC	As TC or runner in a CEV crew in a CEV, in combat or during a firing exercise Target is visible	Obtain second round hit within 20 seconds for at least 80% of targets engaged	001 Recall location and function of switches, controls and indicators 014 Operate fire control equipment
1.	Keep sight on aiming point and sense burst		Maingun is foresighted and zeroed		016 Recall mistfire procedures
	announce the sighting i.e., "SHORT-B-O-T"		Target has been detected, identified and is under engagement		024 Determine target azimuth
3.	Location of burst becomes the BOT aiming point				025 Use binoculars and range formula to estimate range
4.	Reposition gun so that BOT aiming point is on the target				034 Recall elements of a fire command
5.	When loader announces "UP", announce "ON THE WAY" and press firing trigger				035 Operate CEV intercom system
6.	Score the round and re-align if required. Continue to repeat sequence until target is destroyed. If sighting is "lost" announce "PROP 100" and continue to engage				036 Operate maingun controls 037 Recall best method of destruction for target types
7.	TC terminates engagement by commanding "CEASE FIRE"				C2301 Respond to a fire command

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### 3. Target Engagement

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C2305

## 17. INITIATING CUES

18. CONDITIONS

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## SEVEN

CS301 Issue a fire command

C2304 Determine target range
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OB TITLE	12F
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DOS

### 3. Target Engagement

EVENTS  
J. P. M.

### CONDITIONS

STANDARDS

NOTES

C2304 Determine target

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Section 60

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B TITLE 12F

DOS CEV Gunnery Tasks

TY CODE 3. Target Engagement

LEVEL SL2

ITEM CODE	TASK, ELEMENTS J.F.M.	17. INITIATING CUES	18. CONDITIONS	19. STANDARDS	20. NOTES
2307	Engage targets with 7.62mm coax MG (as gunner)	TC announces "GUNNER-COAX"	As the gunner in a CEV crew in a CEV, in combat or during a firing exercise and target area is covered within 20 seconds	Firing commences within 5 seconds of initial command	001 Recall location and function of switches, controls and indicators
1.	Set turret power and machine gun switches to ON		During daylight 7.62mm coax MG is mounted, boresighted, zeroed and loaded		010 Recall ammunition safety cautions and warnings
2.	Search through sight for target, announce "IDENTIFIED" when target is seen		Target is visible		014 Operate fire control equipment
3.	Use initial sight for point target and M92C with HPP reticle for area or moving targets				030 Recall CEV capabilities and limitations
4.	Estimate target ranges, and adjust gun for azimuth and elevation				032 Recall that dangerous targets may require immediate engagement without regard to firing positions
5.	Upon command "FIRE" announce "ON THE WAY" and commence firing				034 Recall elements of a fire command
6.	Use appropriate target engagement technique firing 20-25 round bursts				035 Operate CEV intercom system
7.	For moving targets use initial lead of 5 miles, and adjust for observing strike or as directed by TC				052 Recall target engagement techniques for machine gun engagements
8.	Upon command "CEASE FIRE"				C2301 Respond to a firing command

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Prescribe all use of this form and its contents

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DOS  
CEI' Gunnery Tasks

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20. NOTES

038 Recall techniques  
for target detection

CL302 Direct a  
ty targets

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Date

OB TITLE		12F		DOS		CEV Gunnery Tasks	
UTY CODE		3. Target Engagement		LEVEL		SL3	
ITEM CODE	TASK, ELEMENTS J.P.N.	17. INITIATING CUES	19. CONDITIONS	19. STANDARDS	20. NOTES		
C3302	Engage targets during limited visibility (as TC)	Engagement of a target on range card has been directed or determined	As TC in a CEV crew in a CEV in combat or during firing or training exercise, during a period of limited visibility or darkness	All elements of firing command are properly announced	001 Recall location and function of switches, controls and indicators		
1.	Identify target on range card			Correct azimuth and quadrant elevation are reported from range card	014 Operate fire control equipment		
2.	Initiate fire mission by announcing "QUICKER-HIT"		Range card has been prepared		016 Recall misfire procedures		
3.	Determine target deflection from range card, and announce deflection to gunner		Maintain as bore-sighted and zeroed		023 Identify potential targets		
4.	Determine quadrant elevation from range card, and announce to gunner				024 Determine target azimuth		
5.	Verify deflection and quadrant elevation as read back by gunner, and Loader says "Up"				034 Recall elements of a fire command		
6.	Command "Fire"				036 Operate maingun controls		
7.	Observe burst, correct aim as required				037 Recall best method of destruction for target types		
8.	Assess damage and terminate engagement when target is destroyed				C3301 Issue a firing command		
					C3201 Prepare range cards		

JOB DATA WORKSHEET  
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OB TITLE		DOCS		CEV Gunnery Tasks	
12F		LEVEL		SL3	
UTY CODE		3. Engage Targets			
ITEM CODE	TASK ELEMENTS	17. INITIATING CUES	18. CONDITIONS	19. STANDARDS	20. NOTES
G3303	16. J.P.M. Illuminate targets with searchlight (as TC)	Illumination mission is directed or required	As TC in a CEV crew in a CEV in combat or during a training or firing exercise during darkness	All elements of firing command are properly announced	001 Recall location and function of switches, controls and indicators
1.	Identify target on range card, and determine type of illumination required		Searchlight is mounted and boresighted	Correct azimuth and quadrant elevation are reported from range card	014 Operate fire control equipment
2.	Initiate fire mission by announcing "CHUCKER-WHITE LIGHT" (or "BLACKLIGHT")		Range card has been prepared	Correct search light employment techniques are used	023 Identify potential targets
3.	Determine target deflection from range card and announce to gunner			Target is illuminated	034 Recall elements of a fire command
4.	Determine quadrant elevation from range card and announce to gunner			Cautions and warnings are observed	035 Operate CEV intercom system
5.	Verify deflection and quadrant elevation as read back by gunner				036 Operate maingun controls
6.	Set controls on M/VSS-1 control box for desired illumination				038 Recall techniques for target detection
7.	Announce "ILLUMINATE" and turn on searchlight				039 Recall that CEV's mounting searchlights do not fire while illuminating because of smoke and dust obscuration
8.	Correct searchlight position as required				040 Recall that CEV's with searchlight mounted should not fire because of possible muzzle blast damage to searchlight

3. 130 7 APPENDIX

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JOB TITLE	DOS	CEV Gunnery Tasks
DUTY CODE	LEVEL	SL3
9.	16. TACK, ELEMENTS J.P.N.	17. INITIATING CUES
C303	Use correct searchlight technique	18. CONDITIONS
10.	Terminate mission when completed	19. STANDARDS
		20. NOTES
		041 Recall techniques for searchlight employment
		042 Recall that searchlight must not be used in overdrive more than once every five minutes
		043 Use appropriate sighting equipment for blacklight
		044 Recall that CEV should move to alternate position as soon as possible
		C301 Issue firing command
		C301 Prepare range cards

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JOB TITLE 12F		DOS CEV Gunnery Tasks			
RTY CODE 3. Target Engagement		LEVEL SL3			
ITEM CODE	TASK, ELEMENTS J.P.M.	17. INITIATING CUES	18. CONDITIONS	19. STANDARDS	20. NOTES
C3304	Engage targets with maingun using rapid sequential round (IC)	Previous round error can not be corrected using BOT, or sensed as "LOST"	As TC in a CEV crew, in a CEV in combat, or during a firing exercise, target is visible	Obtain second round hit within 20 seconds for at least 80% of targets engaged	001 Recall location and function of switches, controls, and indicators
1.	Sense round or receive sensing from runner or driver				014 Operate fire control equipment
2.	Initiate subsequent fire command by announcing "SHORT" or "OVER"		Maingun is bore-sighted and zeroed		016 Recall misfire procedures
3.	Correct deflection by announcing direction and mils e.g. "LEFT-2" or "RIGHT-3"		Target has been detected, identified and is under engagement		014 Determine target azimuth
4.	Correct elevation by announcing direction and mils e.g. "DOWN 50" or "UP 25"				015 Use binoculars and MOPV formula to estimate range
5.	After gun is repositioned and leader announces "UP", command "FIRE"				034 Recall elements of a fire command
6.	Sense burst and continue corrections until target is destroyed				035 Operate CEV intercom system
7.	If sensing is LOST, deflection is more than 3 mils or range more than 200 meters off, command "CEASE FIRE" and issue a new fire command to engage				036 Operate maingun controls
					037 Recall best method of destruction for target types
					047 Recall criteria for size of range correction in subsequent fire



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Date

B TITLE		DOS		CEV Gunnery Tasks		Page 43 of 44	
12F		LEVEL		SL3			
3. Target Engagement							
ITEM CODE	TASK, ELEMENTS	17. INITIATING CUES	18. CONDITIONS	19. STANDARDS	20. NOTES		
J04 8.	16. TASK, ELEMENTS	J.P.M.			commands (25 meters for		
	Assess, engage and terminate				measured range, 50 meters		
	immediately when target is de-				for estimated range,		
	stroyed				doubled if miss is over		
					100 meters)		
					C3301 Issue a fire com-		
					mand		
					C3304 Determine target		
					range		

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DOS CEV Gunnery Tasks

12F

LEVEL SL3

3. Target Engagement

ITEM CODE	TASK, ELEMENTS J.P.M.	17. INITIATING CUES	18. CONDITIONS	19. STANDARDS	20. NOTES
03305	Engage ground targets with cal .50 M-85 MG	A .50 cal target is identified	As TC in a CEV crew, in a CEV in combat or during a firing exercise	Open fire within 5 seconds of target designation, and place rounds on target within 20 seconds	UGI Recall location and function of switches, controls and indicators
1.	Initiate engagement by announcing "CALIBER .50"		Cal .50 MG is mounted, boresighted, zeroed, and loaded, N34 or N36 is installed	Fire is continued until target is destroyed, nullified or out of range	010 Recall ammunition safety cautions and warnings
2.	Set cupola power switch to ON; safety to FIRE, and rate switch to LOW				014 Operate fire control equipment
3.	Estimate target range and lay gun on that range line				016 Recall misfire procedures
B-72	As target reticle, using azimuth and elevation controls for cupola				030 Recall CEV capabilities and limitations
4.	Fire 10 to 15 round bursts at low rate				032 Recall that dangerous targets may require immediate engagement without regard to firing positions
5.	Adjust fire by "walking" tracers into target area				034 Recall elements of a fire command
6.	Terminate engagement by announcing "TC COMPLETE"				035 Operate CEV intercom system
7.	Place safety switch to OFF				050 Recall loading procedures for cal .50 machine gun

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DATE

JOB TITLE		12F		DOS		CEV Gunnery Tasks	
DUTY CODE		3. Target Engagement		LEVEL		SL3	
ITEM CODE	TASK, ELEMENTS J.P.N.	17. INITIATING CUES	18. CONDITIONS	19. STANDARDS	20. NOTES		
C3306	Engage aerial targets with Cal .50 M-85 MG	Aerial attack is underway, unit/supported unit commander directs engagement or	As TC in a CEV crew, in a CEV during combat or firing exercise M-85 is mounted, borsighted, zeroed, and loaded.	Aircraft is engaged before passing over or post the CEV	001 Recall location and function of switches, controls and indicators		
1.	Initiate engagement by announcing "CALIBER .50"	Nearby air defense weapon engages target			010 Recall ammunition safety cautions and warnings		
2.	Set cupola power to ON, safety switch to FIRE, and rate switch to HIGH	Target meets hostile criteria under current control measures	Aircraft meets hostile criteria, and engagement authority has been granted		014 Operate fire control equipment		
3.	Aim above and in front of target and fire a continuous burst until target flies through cone of fire				016 Recall misfire procedures		
4.	Continue to reposition and fire using cone of fire technique until target is destroyed or out of range				030 Recall CEV capabilities and limitations		
5.	Terminate engagement by announcing "IC COMPLETE"				034 Recall elements of a fire command		
6.	Place safety switch to OFF				035 Operate CEV intercom system		
					052 Recall target engagement techniques for machine gun engagements		
					C3101 Load the Cal.50 M-85		
					C3102 Correct a stoppage of a cal .50 M-85 MG using immediate action		
					C3301 Issue a firing command		

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TLE	12F	DOS CEV Gunnery Tasks			
CODE	3. Target Engagement		LEVEL	SL3	
	TASK, ELEMENTS J.P.M.	17. INITIATING CUES	18. CONDITIONS	19. STANDARDS	20. NOTES
	Engage targets with 7.62mm coax MG (as TC)	Coax gun target is selected or designated	As TC in a CEV crew, in a CEV in combat or during a firing exercise during daylight	Firing commences within 5 seconds of initial command and target area is covered within 20 seconds	001 Recall location and function of switches, controls and indicators
	Visually acquire target and identify				010 Recall ammunition safety cautions and warnings
	Command "GUNNER-COAX" and lay on target		7.62mm coax MG is mounted, boresighted, zeroed, and loaded	All commands are correctly given	
	Identify target e.g. "TROOPS" or "TRUCK" and estimate range		Target is visible		014 Operate fire control equipment
					030 Recall CEV capabilities and limitations
	Upon receiving "UP" from loader and "IDENTIFIED" from gunner, command "FIRE" and observe fire				032 Recall that dangerous targets may require immediate engagement without regard to firing positions
	Announce adjustments to gunner in shortest possible terms				034 Recall elements of a fire command
	Assess damage and terminate engagement when target is destroyed, neutralized, or out of range by commanding "CEASE FIRE"				035 Operate CEV intercom system
					052 Recall target engagement techniques for machine gun engagements
					C2304 Determine target range
					C3301 Issue a firing command

APPENDIX C

OPERATIONAL SEQUENCE DIAGRAMS  
FOR CEV GUNNERY

## Operational Sequence Diagrams for Collective CEV Gunnery Tasks

In order to facilitate evaluation of DORACs for assessing gunnery proficiency of CEV personnel, operational sequence diagrams (OSDs) have been prepared which depict the flow of activities performed in conduct of CEV gunnery tasks and describe the actions and interactions of crew members as activities are performed. Successful employment of the CEV as a demolition weapon depends on the extent to which the crew functions as a coordinated team. Thus, in order to be maximally useful, DORACs for CEV gunnery should provide for the assessment of CEV crew readiness. By comparing the OSD descriptions of crew requirements in gunnery task performance against the scenario and evaluation capabilities of various DORACs proposed, we can identify the DORACs that have the greatest ability to assess CEV crew readiness.

A master flowchart has been prepared which portrays the sequence of activities required in conduct of firing missions. Blocks 1.0 through 5.2-2 describe activities performed to prepare the CEV for a firing mission. Included in these activities are stowing the basic load of ammunition for the weapons systems, performing all checks of the weapons system, boresighting the weapons, and loading and zeroing the machineguns. Activities performed in conduct of various types of firing missions are presented in blocks 7.0 through 53.0. Firing missions are distinguished in terms of whether the CEV is firing from a predetermined firing position using a range card (blocks 11.0-13.0) or from a position taken while moving in support of a maneuver force (blocks 7.0-9.0) and on the basis of the weapon system employed: machinegun (block 15.0), searchlight (27.0), or maingun (32.0).

Combining various activity blocks on the master flowchart, seven collective tasks have been developed that encompass crew requirements for the gunnery portion of CEV employment. The seven collective gunnery tasks are:

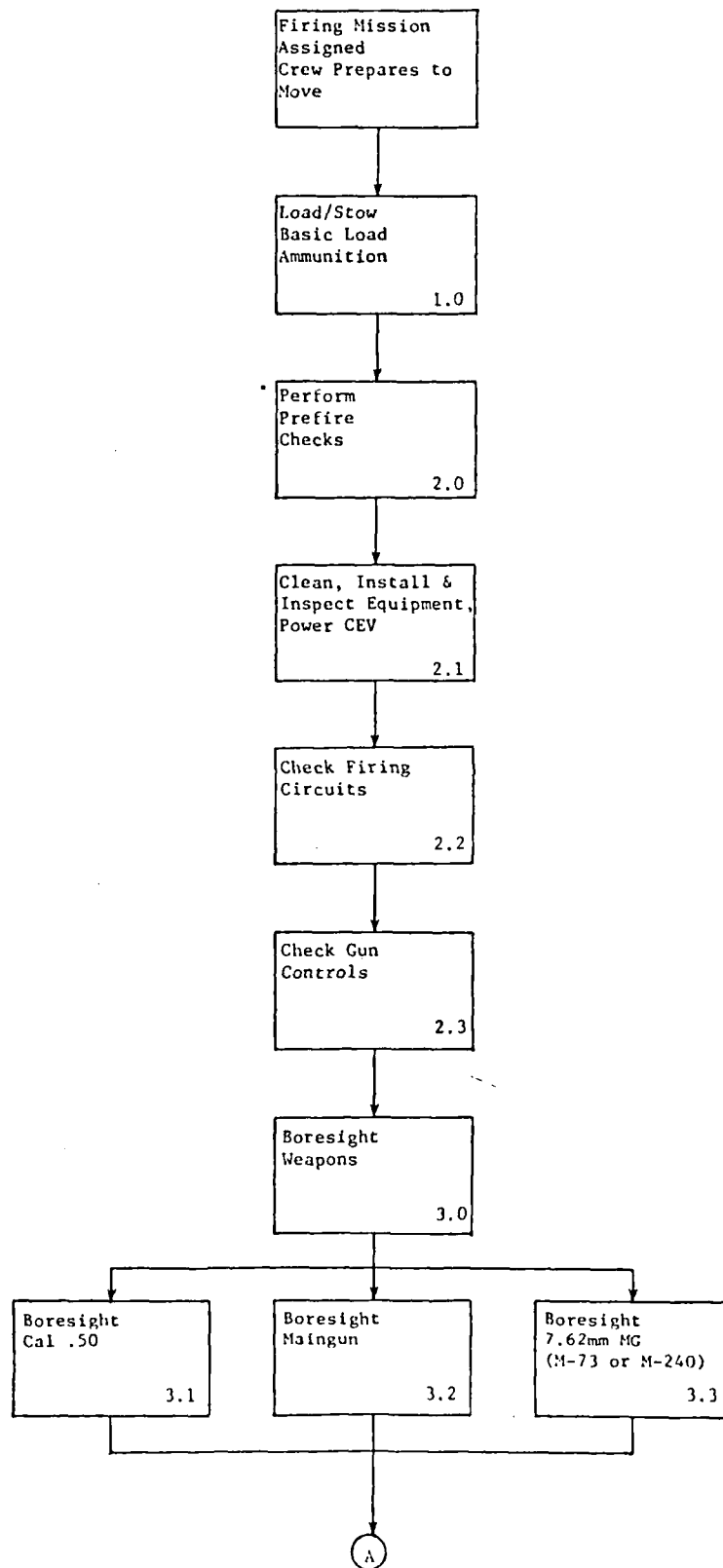
1. Preparation of CEV for Firing Mission.
2. Engagement of Targets with 7.62mm Coax Machinegun.
3. Engagement of Aerial Targets with Cal .50 Machinegun.
4. Engagement of Ground Targets with Cal .50 Machinegun.
5. Engage Targets with Searchlight from Predetermined Positions.
6. Engagement of Targets with 165mm Gun from Predetermined Firing Position

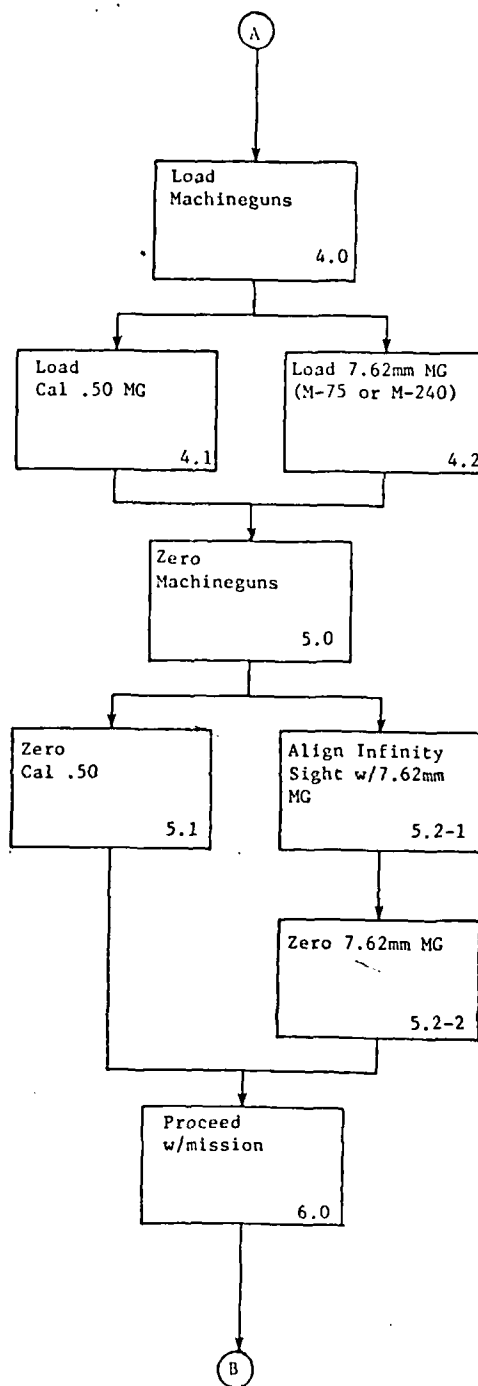
#### 7. Engagement of Targets with 165mm Gun as Part of Maneuver Force.

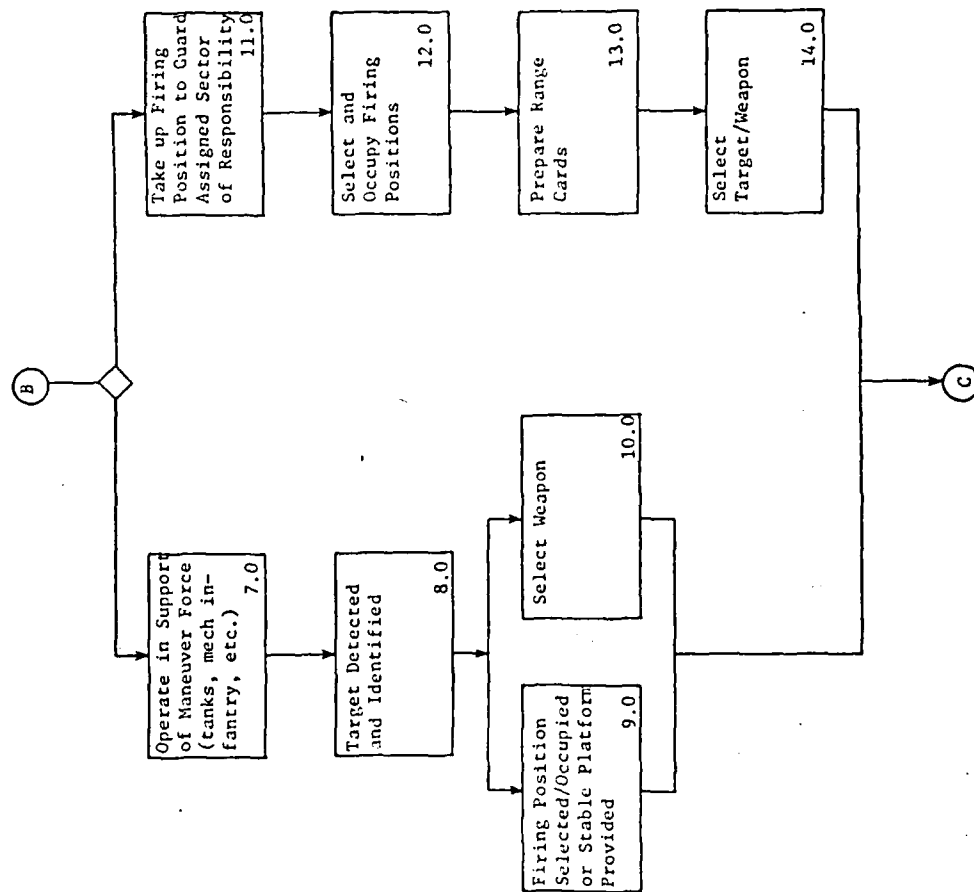
Task descriptions consist of a flowchart of activities performed during conduct of the task followed by verbal descriptions of actions performed by the different CEV crew members during task performance. Activities presented in a task flowchart are numbered in reference to activities in the master flowchart. The verbal description of task activities consists of four panels (one for each crew member) divided into a series of blocks. A description of a particular action performed by a crew member in performance of a task activity is provided in a block. In the lower right hand corner of each block with text is an alphanumeric code which keys the action performed in the block to an activity in the task and master flowcharts (i.e., 5.0, 10.0, etc.), identifies the position of the action in the sequence of actions that accomplish the activity (i.e., 1st action, 2nd action, etc.), and identifies the crew member that performs the action (a=tank commander, b=gunner, c=loader, d=driver). For example, a block numbered 10.2c refers to an action performed by the loader which is the second action in the sequence of actions performed to accomplish activity 10. Note that actions described in a block can be a part of more than one activity.

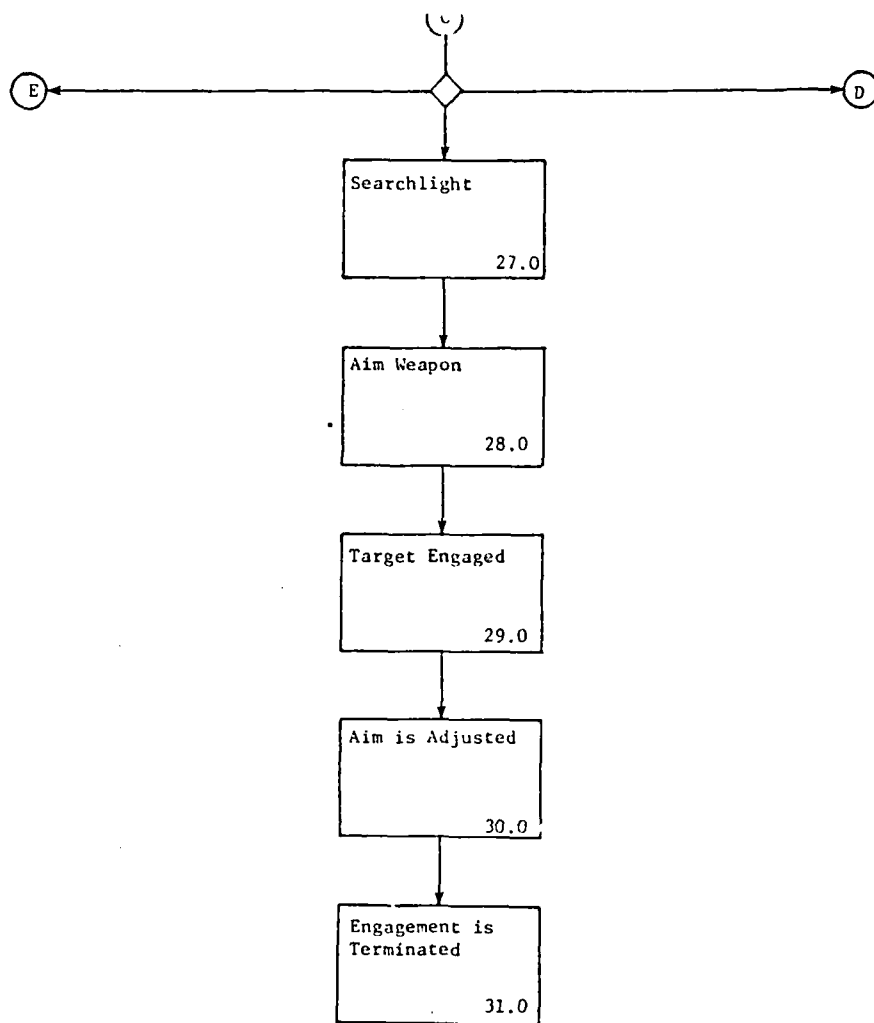
In the lower left hand corner of each block is another alphanumeric code in parentheses. The action descriptions provided in the different blocks were taken from the individual task descriptions prepared earlier. The codes in parentheses reference an action to a specific individual task (first five digits) and element of that task (digits following the decimal).

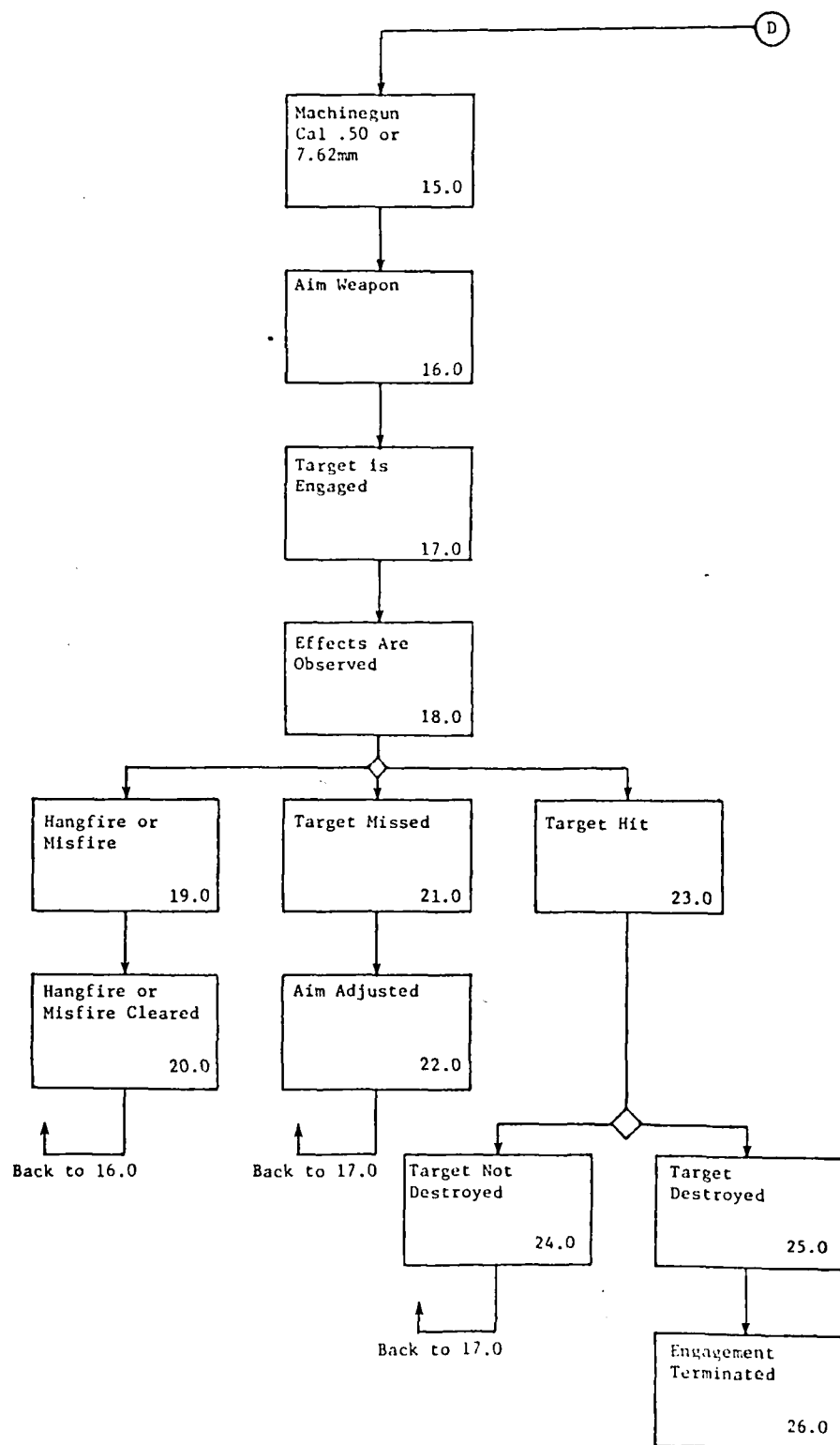


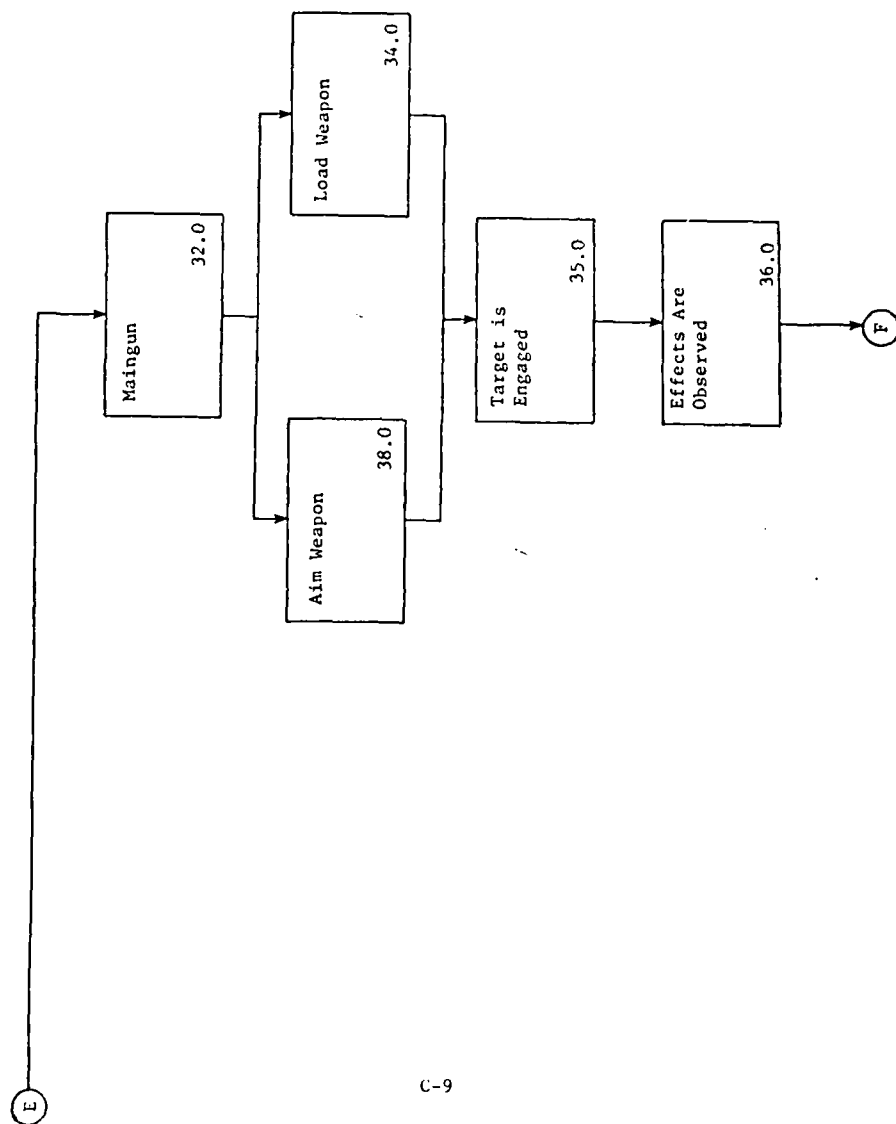


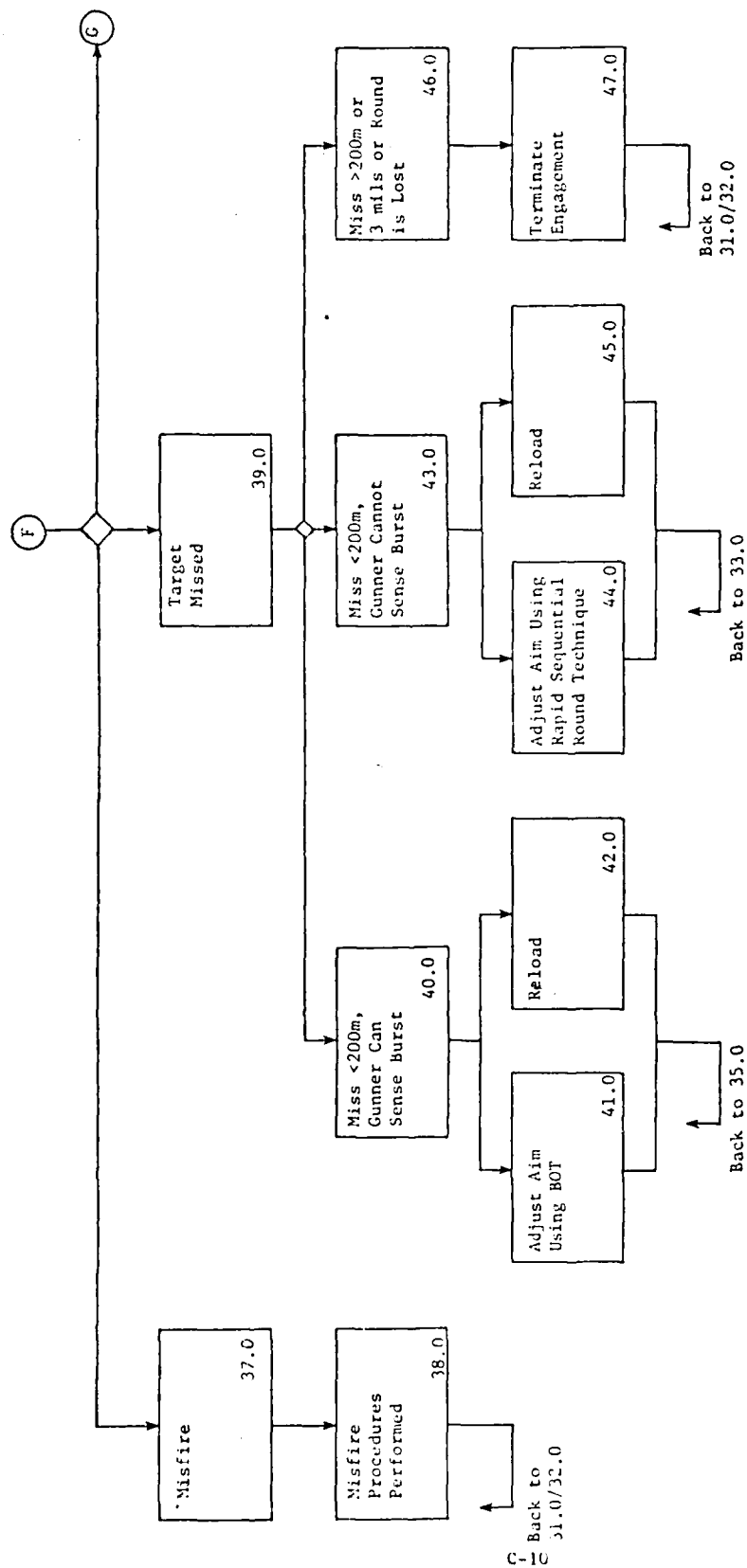


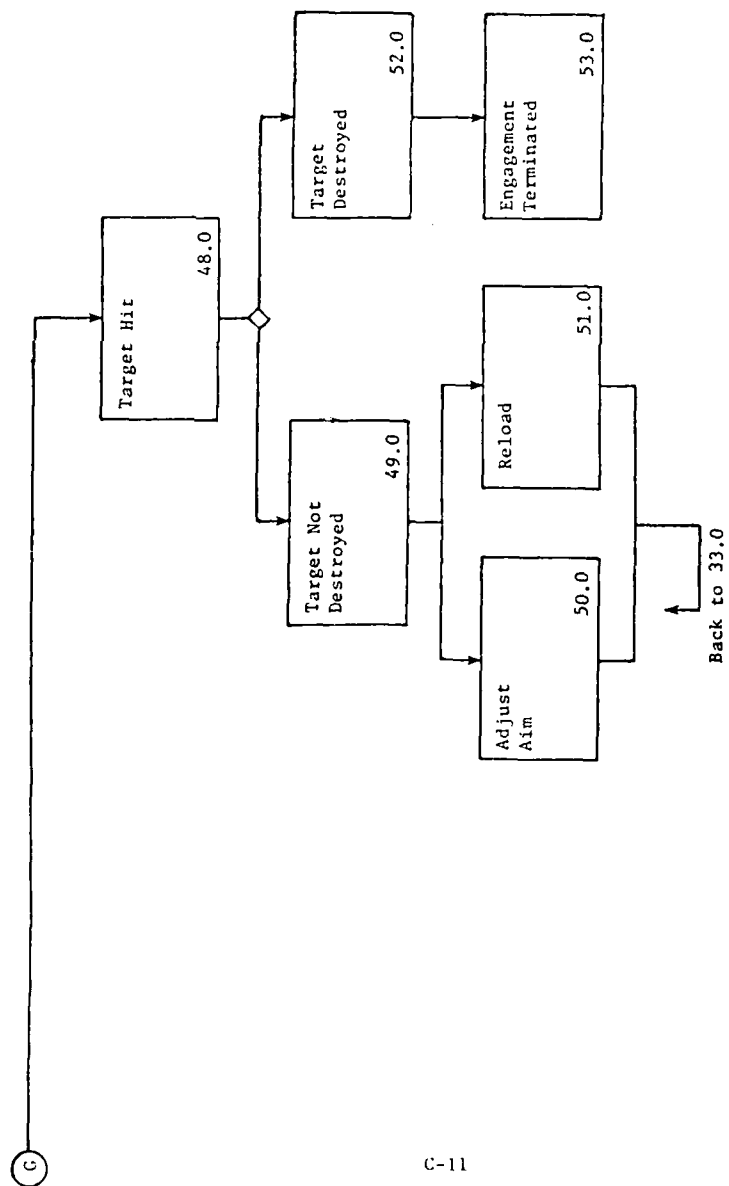




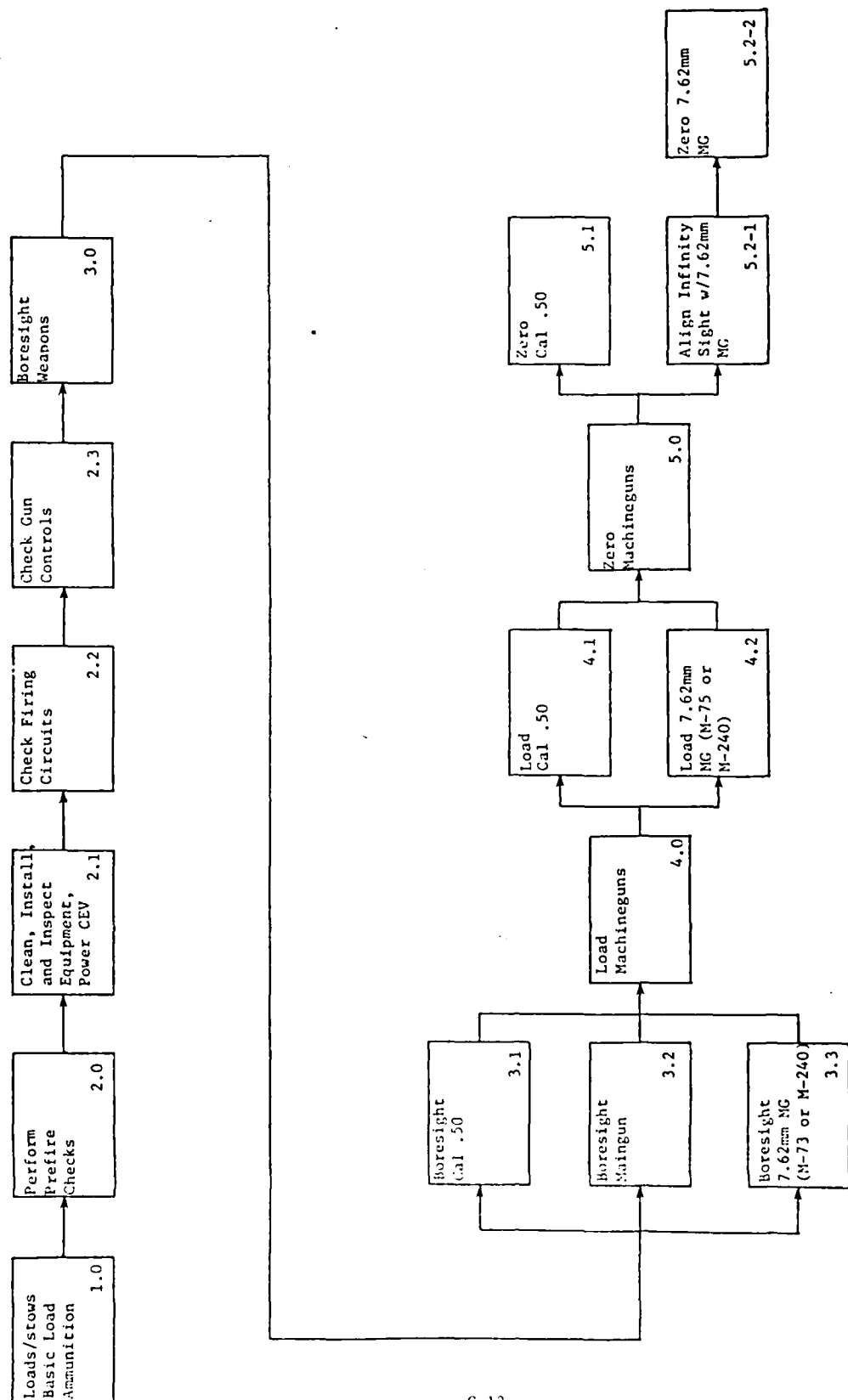












Conditions: A CEV crew has been assigned a tactical mission in which use of weapons systems is anticipated.

Tank Commander							
Gunner							
Loader	Installs and secures inner 165mm rounds in ready rack (C1102.1/2)	Installs and secures outer 165mm rounds in ready rack (C1102.3/4)	Installs and secures 165mm rounds in the tubular stowage rack (C1102.7)	Stows 6.62mm ammuni- tion in hull and turret racks (C1104.2)	Stows cal .50 ammuni- tion in hull and turret racks (C1104.3)	Stows cal .45 ammuni- tion in turret racks (C1104.4)	1.0.6c
Driver							

Tank Commander	"Prepare to Fire" (C3001.1)	2.0.1a	Cleans turret ex- terior lens and vision devices (C3001.2)	2.1.1a	Checks M34 or M36 periscope (C3001.3)	2.1.2a			Checks instrument lights and controls
Gunner			Observes loader's check of replenisher indicator tape (C2001.1)	2.1.1b	Installs, cleans, and inspects direct fire sights (C2001.2)	2.1.2b	Checks operation of ballistic shield (C2001.3)	2.1.3b	2.1.4b
Loader	Stows hand grenades (C1104.5)	1.7c	Reads replenisher indicator tape and services as required (C1002.1)	2.1.1c	Inspects maingun tube (C1002.2)	2.1.2c	Check 7.62 MG mount (C1002.3)	2.1.3c	Inspects all turret hull stowed ammuni- tion for proper stor- age, complete load, and serviceability (C1002.4/9)
Driver			Cleans periscopes	2.1.1d	Lowers seat (C1002.2)	2.1.2d	Closes hatch	2.1.3d	Positions master battery switch to "ON" 2.1.4d

Tank Commander			"Check firing switches" (C3001.4)	2.2.1a		Operate T.C.'s controls during test (C3001.5)	2.2.3a	"Check gun controls" (C3001.6)	2.3.1a	Checks gun control: for power elevation and traverse (C3001.7)	2.3.
Gunner						Operates gunner's controls during test (C2001.5)	2.2.3b			Checks gun control: power pack, oil level and equilibrator hydraulic fluid level (C2001.6)	2.3.2
Loader	Switches radios OFF during engine start (C1002.5)	2.1.5c			Installs firing circuit tester (C1002.6)	2.2.2b	Operates loader's controls during test (C1002.7)	2.2.3c		Assists w/checking of gun controls (C1002.8)	2.3.2
Driver	Starts engine 2.1.4d										

Tank Commander	"Check fire control" (C3001.8)	3.0.1a	3.1.1a (C3001.9)	Checks operation of Cal .50 MG mount and controls	3.1.1a (C3001.10)	3.1.2a (C3001.10)	Checks firing opera- tion of Cal .50 MG	Removes body of M34 and M36 periscope	3.1.3a (C3002.1)	3.1.4a (C3002.2)	Places MG in "Safe" position and insures that gun is unloaded	Removes back plate, buffer group, gear assembly, and bolt assembly	3.1.5 (C3002.3)
			3.2.1b (C2001.7/8)	Checks azimuth indi- cator for accuracy and checks elevation quadrant	3.2.1b (C2006.1)	3.2.2b (C2006.1)	Sets elevation/trav- erse power switch and maingun switch to OFF and master battery switch to ON. Unlocks turret traverse lock	Directs loader to secure boresight cord over muzzle	3.2.3b (C2006.2)	3.2.4b (C2006.3)	Locks breech open and installs breech bore- sight	Aligns bore with right angle corner o target using manual elevation and traverse	3.2.5 (C2006.4)
Loader											Secures boresight cord over muzzle witness lines with tape	Assists gunner with boresighting	
										3.2.4c (C1002.11)	3.2.5 (C1002.10)		3.2.5
Driver													

Tank Commander	Aligns center of barrel w/aiming by manually positioning the cupola and engaging the azimuth lock (C3002.4) 3.1.6a	Installs the M34 periscope and adjust elevation & traverse until 500m aiming point is aligned w/aiming point. Rotate slip scale on elevation & deflection knobs to read 4 (C3002.5) 3.1.7a	Removes M34 and install M36 periscope (C3002.6) 3.1.8a	Adjusts elevation & traverse until 500 meter aiming point is aligned w/aiming point. Rotate slip scales on elevating knobs to read 4 and 4 (C3002.7) 3.1.9a	Removes M36 body (C3002.8) 3.1.10a	Reassembles bolt assembly, buffer group, and backplate (C3002.9) 3.1.11
Gunner	Selects HEP reticle in 105F telescope and adjusts telescope reticle to aiming point and verifies bore on aiming point (C2006.5) 3.2.6b	Installs and adjusts visible light body reticle for M32C periscope. Installs IR body cover head leaving 3/4 inch hole & adjusts reticle (C2006.6) 3.2.7b	Lays boresighted maingun on aiming point (C2002/3.1) 3.3.1b	For M-75: Sets elevation/traverse switch to OFF, verifies that gun is unloaded & safety is in "S" position (C2002.2) 3.3.2b	M-75: Loosens 3 set screws on outside collar (C2002.3) 3.3.3b	Remove electrical load from receiver receiver from jack assembly (C2002.4) 3.3.4i
Loader						
Driver						

Tank Commander	Installs desired periscope body (C3002.10) 3.1.12b								
Gunner	Loosens mounting screws, jam and locking nuts for vertical and horizontal adjustments (C2002.5) 3.3.5b	Focus on aiming point w/sight side of M17A1 binoculars through bore and align bore w/aiming point (C2002.6) 3.3.6b	Tighten mounting screws, locking and jam nuts, & reassemble receiver. Reconstructs electrical lead (C2002.7) 3.3.7b	Tighten collar set screws (C2002.8) 3.3.8b	For M-240: Sets elevation/traverse switch to OFF, verifies that gun is unloaded and safety is in "S" position, ensures bolt is forward (C2002.2) 3.3.2b	M-240: Removes buffer, driver spring, mounting p slide rod, and bolt assembly (C2003.3) 3.3.3b			
Loader									
Driver									

Tank Commander							
Gunner	Loosens mounting nut & tightens to 1/3 turn past touching washer (C2003.4) 3.3.4b	Focus on aiming point with sight side of M17A1 binoculars through bore & align bore w/aiming point (C2003.5) 3.3.5b	Tighten mounting nut & recheck bore align- ment (C2003.6) 3.3.6b	Reassemble machine gun (C2003.7) 3.3.7b	Return bolt to forward position (C2003.8) 3.3.8b		
Loader						Removes boresight cord from muzzle or main gun (C1002.11) 3.3.9	
Driver							



Tank Commander		Commands, "Load machine guns"	4.0.1a	Raises cradle access door and cover assembly and latches it open	(C210i.1) 4.1.1a	With bolt in rear position, checks that chamber is empty	(C3101.2) 4.1.2a	Closes bolt slowly	(C3101.3) 4.1.3a	Places ammunition in feed box and feeds 3 or 4 rounds into flexible chute	(C3101.4) 4.1.4
Gunner	Stows tools and equipment (C2002/3.9) 3.3.11c										
Loader				Checks that traverse lock is set to "Lock", ELEV/TRAV PWR switch to OFF, and machine gun switch to OFF	(C1105/6.1) 4.2.1c	For M-75: Raises receiver cover and feed tray	(C1106.2) 4.2.2b	Sets safety to F (fire) and pulls charging handle to rear	(C1106.3) 4.2.3b	Checks that barrel extension is back a chamber is clear, then lowers feed tr	(C1106.4) 4.2.4
Driver											

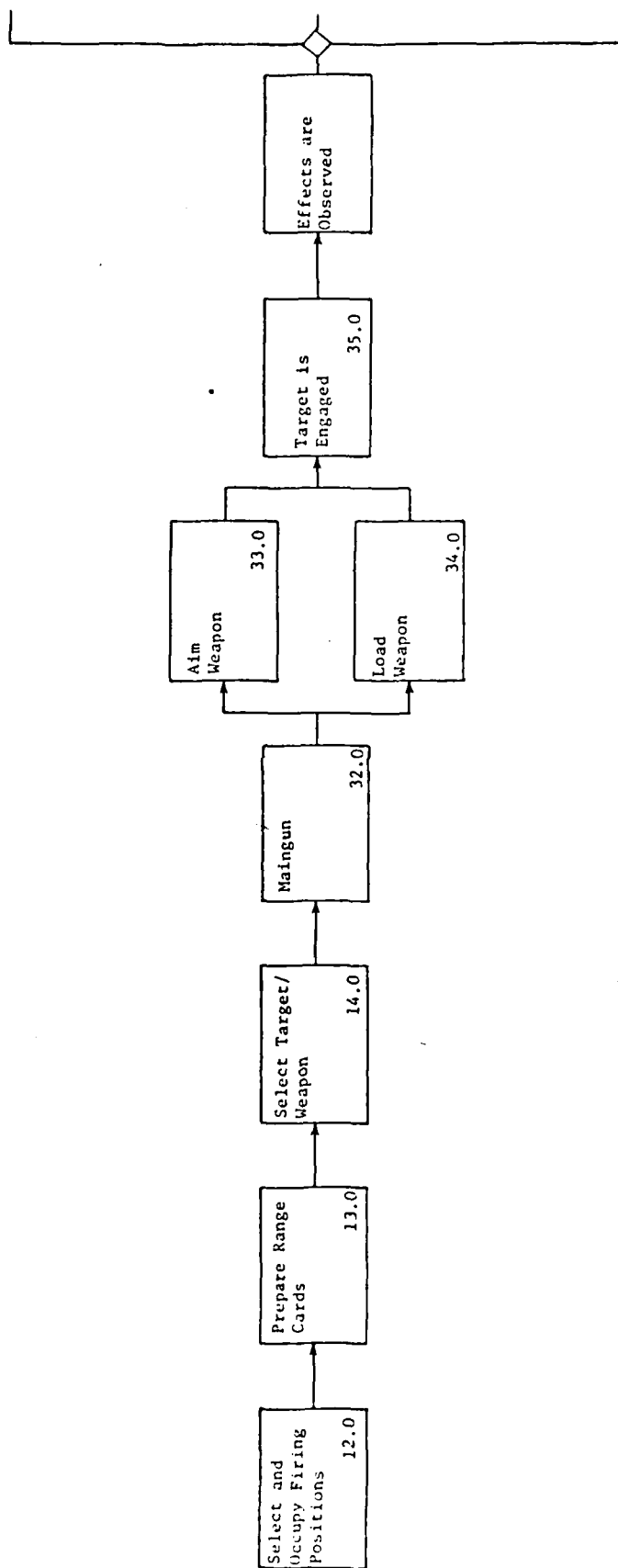
Tank Commander	Feeds rounds through flexible chute and places lead round on tray w/open side of links down (C3101.5) 4.1.5a	Closes cover assembly (C3101.6) 4.1.6a					
Gunner							
Loader	Feeds ammunition belt through chute, places 1st round in feed tray w/1st round over slot in feed tray (C1106.5) 4.2.5b	Closes cover and checks that cover latch is forward (C1106.6) 4.2.6c	For M-240: Pull charger handle to rear and sets safety to S (safe) (C1105.2) 4.2.2c	Raises cover and feed tray and checks that chamber is clear. Lowers feed tray. (C1105.3) 4.2.3c	Feeds ammunition belt through chute, places 1st round in tray w/open side of link down, and pushes against cartridge stop (C1105.4) 4.2.4c	Closes latch and locks cover, and checks that latches are locked (C1105.5) 4.2.5c	
Driver							

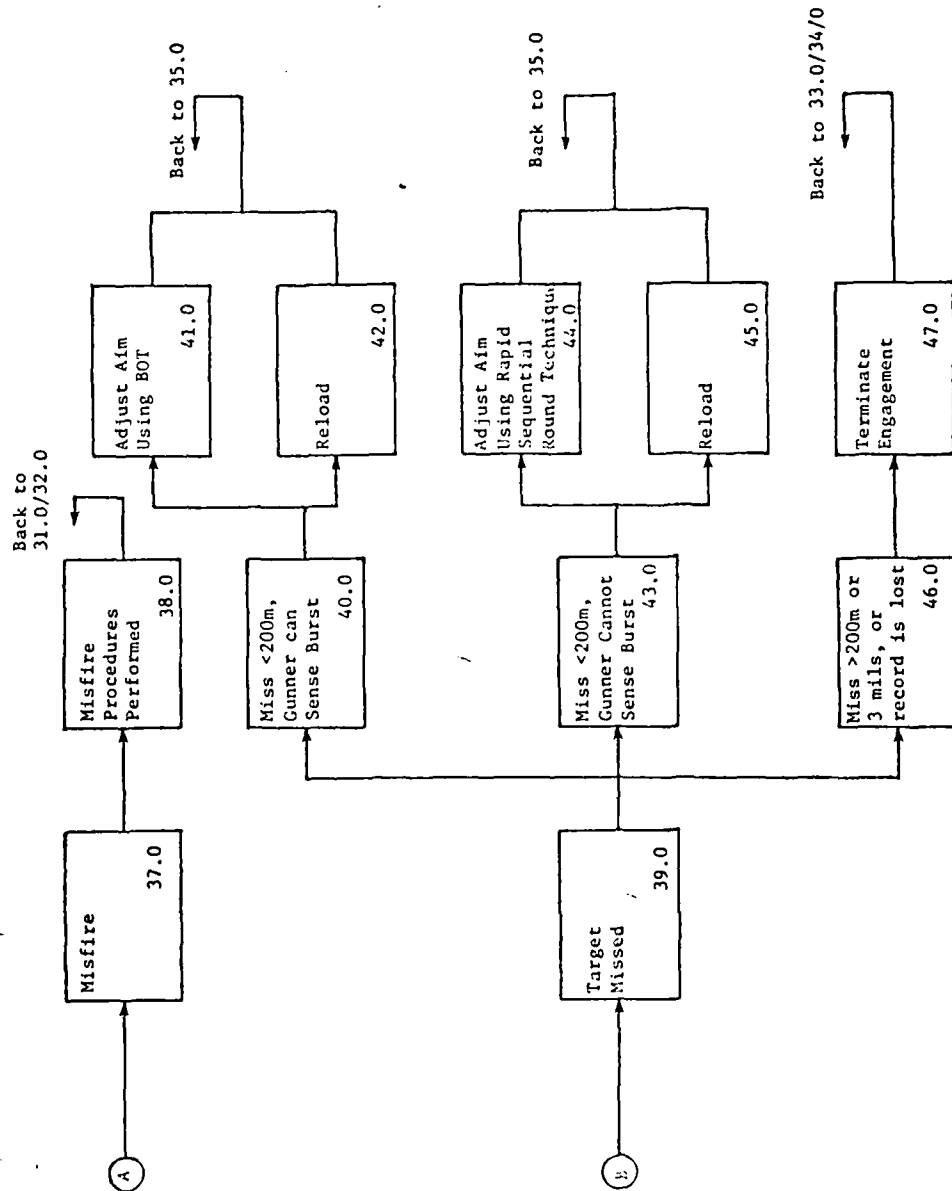
Tank Commander	Operates charger handle to recharge gun, places safety in the "S" position (C3101.7/8) 4.1.7a	Orders "Report" (C3001.14) 2.0.2a	Orders, "Driver move to firing range" 5.0.1a	Orders "Zero machine guns" 5.0.3a	Uses M34 or M35 per scope to lay gun on 500 meter aiming point by traversing and elevating cupol (C3003.1) 5.1.1
Gunner		Replies, "Gunner Ready" (C2001.10) 2.0.2b			Lays 7.62mm MG on aiming point at 500 meters (C2004.1) 5.2-1.
Loader		Replies, "Loader Ready" (C1002.13) 2.0.2c			
Driver		Reply "Driver Ready" 2.0.2d	Driver maneuvers CEV to firing range and positions CEV on firing line 5.0.2d		

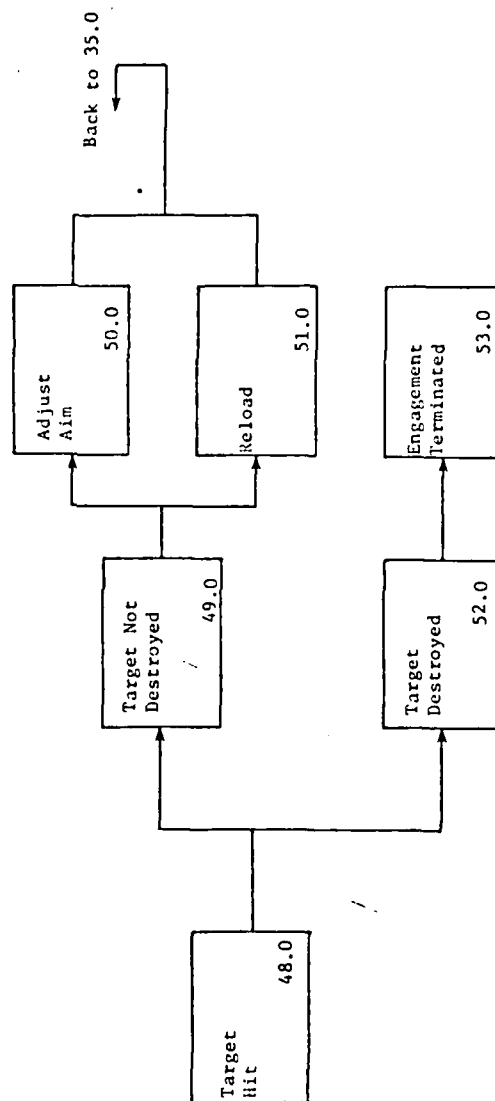
Tank Commander	Fires a 10 to 20 round burst (C3003.2) 5.1.2a	Checks lay on gun after firing and re- adjusts to aiming point if necessary (C3003.3) 5.1.3a	Without moving gun lay, adjusts periscope deflection & elevation until 500 meter aiming point is at center of burst strike area (C3003.4) 5.1.4a	Fires another 10 to 20 round burst to confirm zero (C3003.5) 5.1.5a	Repeats procedure for other periscope (C3003.6) 5.1.6a	If preparing for night engagements, verifies nonballistic reticle aiming point of M36 in periscope by firing burst at same target dusk or with searchlight illumination (C3003.7) 5.1.7
Gunner	Sets master battery switch and infinity toggle switch to ON & adjusts infinity reticle brightness (C2004.2) 5.2-1.2b	Adjusts infinity reticle in elevation & azimuth to align reticle w/aiming point (C2004.3) 5.2-1.3b	Lays 7.62mm gun on 600 meter aiming point using M32C periscope (C2005.1) 5.2-2.1b	Adjusts light intensity of infinity sight reticle (C2005.2) 5.2-2.2b	Fires 20-25 round burst (C2005.3) 5.2-2.3b	Without disturbing gun lay, uses infinity sight boresight knob to center strike area in the reticle (C2005.4) 5.2-2.4b
Loader						
Driver						

Tank Commander	Announces, "Cal .50 zeroed"	5.1.8a					
Gunner	Lays gun again to aim- ing point and fires another 20-25 round burst	Repeats process until burst is inside sight reticle	Announces, "Coax zeroed"				
Loader	(C2005.5) 5.2-2.5b	(C2005.6) 5.2-2.6b	5.2-2.7b				
Driver							

# Engagement of Targets With 165mm Gun From Predetermined Firing Position









Conditions: A CEV has been assigned the mission of guarding a particular sector of responsibility to deny enemy the use of transportation routes (bridges, tunnels, roads, etc.) or concealment (buildings, etc.)

Tank Commander	Considers sector of responsibility, observation and fields of fire, and cover and concealment (C3202.1-3) 12.1a	Selects primary position, alternate positions and secondary positions (C3202.4-6) 12.2a	Designates firing position to driver & designates route to firing position (C3203.1/2) 12.3a	When required, dismounts and guides vehicle into position using proper arm and hand signals (C3203.3/4) 12.5a	
Gunner					
Loader					
Driver			Maneuvers CEV to firing position (C1201.1/2) 12.4d	Selects hull down position and stops vehicle on most level ground available (C1201.3/4) 12.6d	

Tank Commander	Prepares sketch map of target area using military and map symbols	13.1a	13.1a	Selects reference point in coordination with gunner	13.2a	Azimuth indicator is zeroed on reference point	13.3a	Reference point is plotted on range card	13.4a	Targets are identi- fied on range card	13.5a	Target deflection is recorded	13.6a
		(C3201.1)	(C3201.2)	(C3201.3)	(C3201.4)	(C3201.5)	(C3201.6)	(C3201.7)	(C3201.8)	(C3201.9)	(C3201.10)	(C3201.11)	(C3201.12)
Gunner													
Loader													
Driver													

Tank Commander	Target range is recorded (C3201.7) 13.7a	Quadrant elevation for gun is recorded (C3201.8) 13.8a	Quadrant elevation for searchlight is recorded (C3201.9) 13.9a	CEV's sector of responsibility is recorded (C3201.10) 13.10a	Marks range card for appropriate firing position (primary, alternate, secondary) 13.11a	Announces "Gunner HEP, Tunnel (bridge, etc.)" (C3301.2/3) 14.1.
Gunner	Target range is recorded (C2201.6) 13.7b	Quadrant elevation for gun is recorded (C2201.7) 13.8b	Quadrant elevation for searchlight is recorded (C2201.8) 13.9b	CEV's sector of responsibility is recorded (C2201.9) 13.10b	Marks range card for appropriate firing position (primary, alternate, secondary) (C2201.10) 13.11b	
Loader						
Driver						

Tank Commander					Determines target deflection from range card and announces deflection to gunner (C3302.3) 33.4a		Verifies deflection read back by gunner. Determines quadrant elevation from range card and announces to gunner (C3302.4/5) 33.6a
Gunner	Ensures turret power is ON (C2302.1) 33.1b	Main gun switch power to ON (C2302.1) 33.2b	Looks through sights to acquire target 33.3b			Traverses to announced deflection & reads back deflection (C2302.2) 33.5b	
	Sets main gun safety switch to "SAFE" (C1103.1) 34.1c	Opens breechblock and checks that chamber is empty and clean; swabs breech if necessary (C1103.2) 34.2c	Returns operating handle on breechblock to locked position (C1103.3) 34.3c	Removes projectile from rack, places projectile on breechblock rollers, inserts and seats round (C1103.4) 32.4c		Detaches and removes handle from round and closes breechblock (C1103.5/6) 34.5c	Sets main gun switch to "Fire", positions self clear of recoil path, and announces "Up" (C1103.7/8) 34.6c
Driver							

Tank Commander	Verifies elevation as read back by gunner. Orders "Fire at my command", "...,"Fire." (C3302.5/ C3301.7) 33.8a/35.1a					
Gunner	Sets quadrant elevation on quadrant and zeros bubble, reads back quadrant elevation (C2302.3) 33.7b	Announces, "On the way" and presses firing trigger (C2302.4) 35.2b	Announces "Misfire" (C2101.1) 37.1b	Keeps muzzle trained on target and personnel clear of muzzle and recoil path (C2101.2/3) 38.1b	Attempts to fire by operating gunner and TC hand control trigger, manual elevation firing button and the manual firing handle (C2101.4) 38.2b	
Loader						
Driver						

Tank Commander						Orders "Evacuate CEV"	
						38.7a	
Gunner	Waits 2 minutes after last attempt to fire, and then directs loader to unload round						Bails out
	(C2101.5) 38.3b						38.8b
Loader		Opens breechblock and attempts to unload round	If weapon is too hot waits additional 2 minutes and unloads round	If weapon is still too hot to unload, informs T.C.			Bails out
		(C1101.2) 38.4c	(C1101.3) 38.5c	(C1101.4) 38.6c			38.8c
Driver						Bails out	
							38.8d

Tank Commander						Announces, "Short, BOT" "Long, BOT"	40.1a
Gunner	If round does not "cook off" and after after weapon has cooled, has loader re-enter CEV and un- load round (C2101.8) 38.9b		Directs loader to place unfired round a safe distance from vehicles and all personnel (C2101.9) 38.11b		Insures that round is properly marked, and EOO is notified for disposal of round (C2101.10) 38.13b	Announces, "Short BOT" or "Long BOT"	40.1
Loader		Unloads round (C1101.6) 38.10c		Places round where directed (C1101.7) 38.12c			
Driver							

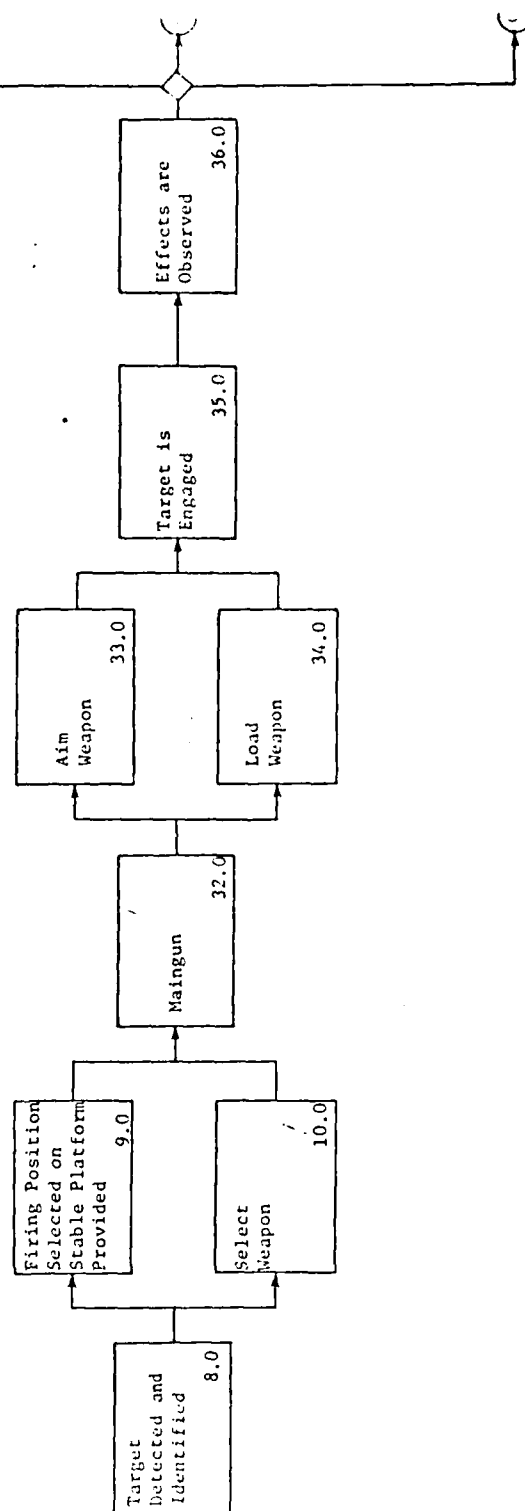
Tank Commander		Announces "Short" or "Over"	Correct deflection by announcing direction and mils (e.g., "Left-2" or "Right-3")	Correct elevation by announcing direction and meters (e.g., "Drop 50" or "Add 100")
Gunner	Uses location of burst as Bof aiming point	Repositions gun so that BOT aiming point is on target	Receive change in deflection in mils, reposition gun in deflection	(C3304.4) 44.3a
Loader	Reloads as described in 34.0 and announces "Up"	Reloads gun as described in 34.0 & announces "Up"	(C2306.1) 44.2b	
Driver			(C1103.1-8) 45,1-6c	

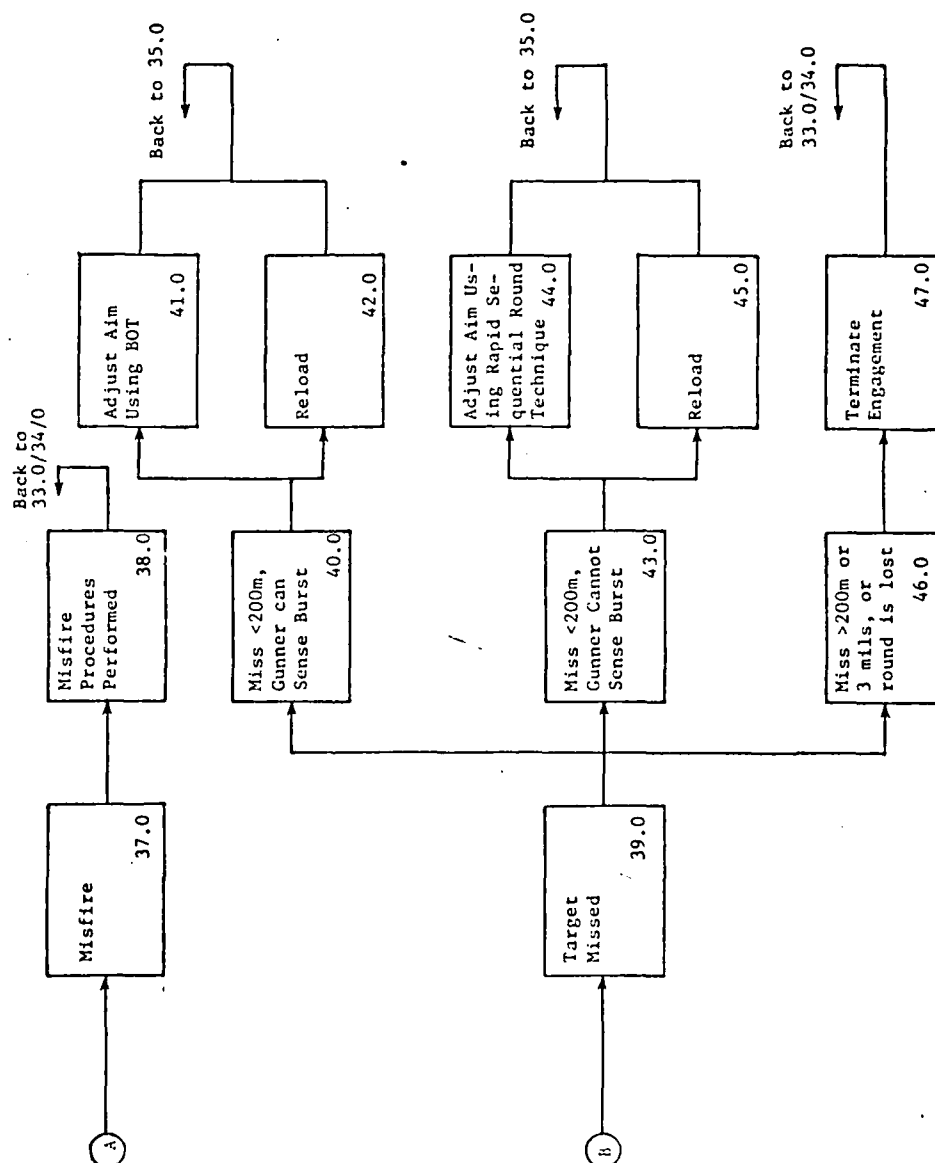


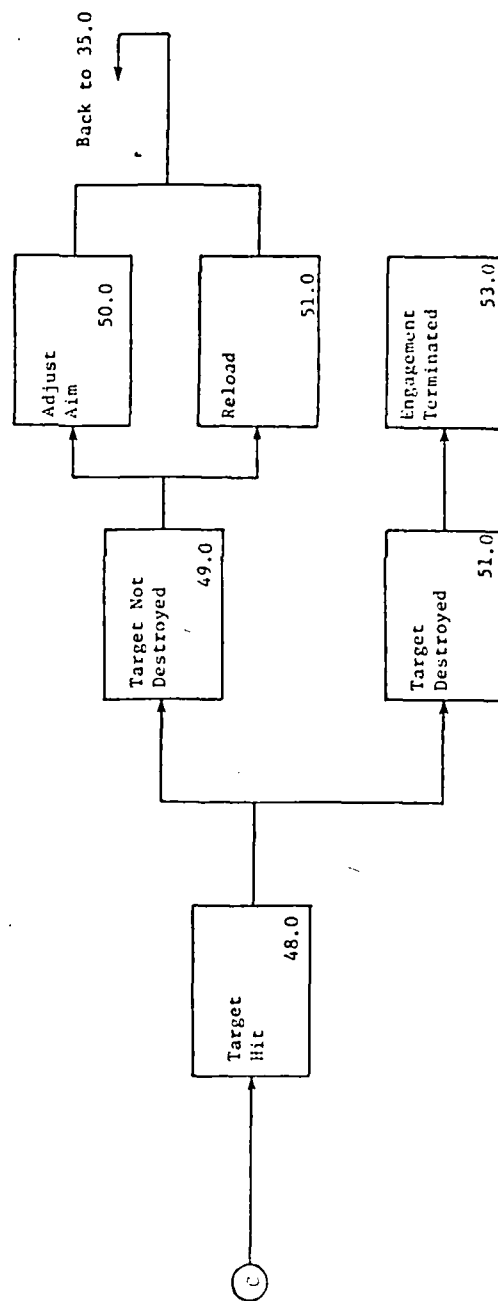
Tank Commander		Announces "Short", "Over", or "Lost"	Commands, "Cease fire"			Sees target is destroyed and commands, "Cease Fire"
		(C3304.2)	46.1a	(C3304.7)	47.1a	(C3304.7) 52.1a/53.
Gunner	Receives change in range in meters if HFF reticle is being used & reposition gun so that center of target is at new range in HFF reticle (C2306.2/3)	44.4b	Announces "Short", "Over", or "Lost"		Observes hit on target and searches for undamaged portion	Adjusts aim so that aiming point is on undamaged portion of target
		(C2306.2)	46.1b		49.1b	50.1b
Loader						Reloads as described in 34.0 and announces "Up"
						(C1103.1-8) 51.1-6c
Driver						

Tank Commander							
Gunner							
Loader						Sets maingun safety switch to SAFE  53.2c	
Driver							

# Engagement of Targets W/165mm Gun as Part of Maneuver Force







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Tank Commander		Orders "Traverse" (right or left)		Orders "Steady"		Calls "ON"
		(C3301.4) 33.2a		(C3301.4) 33.4a		(C3301.4) 33.6a
Gunner			Traverses gun in direction ordered		Slows rate of traverse	
			(C2301.4) 33.3b		(C2301.5) 33.5b	
Loader	Opens breech fully, and checks that chamber is empty & free of debris	Returns operating handle to locked position	Removes round from ready rack, places projectile on breech-block rollers, inserts and seats round	Detaches and removes handle from round	Closes the breech-block	Returns main gun safety switch to F1 and stands clear of recoil path
	(C1103.2) 32.2c	(C1103.3) 34.3c	(C1103.4) 34.4c	(C1103.5) 34.5c	(C1103.6) 34.6c	(C1103.7) 34.7c
Driver						

Tank Commander	Determines target range by: 1. Use of laser range-finder on accompanying tank 2. Use of binoculars & WORM formula 3. Use of Cal .50. 4. Estimation using footbell field as Base (C2301.1-6) 33.7a	Announces, "Range _____ meters" (to nearest 25 meters) (C3301.5) 33.8a		Orders, "Fire at my command, Fire" (C3301.7) 35.1a		
Gunner	Stops traverse and searches for target when visually identified announces "Identified" (C2301.5) 33.7b		Elevates gun to obtain correct sight picture and alignment (C2301.6) 33.9b		Announces, "On the way", and presses trigger (C2301.7) 35.2b	Announces "Misfire" (C2101.1) 37.1b
Loader	Announces, "Up" (C1103.8) 34.8c	Prepares to reload (C1301.5) 34.9c				
Driver						



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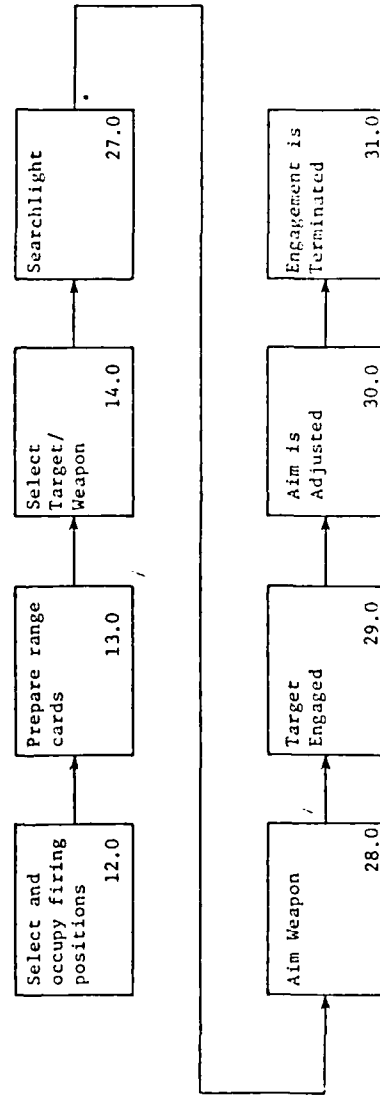
Tank Commander	Orders "Evacuate CEV"					
	38.7a					
Gunner		Bails out	38.8b	if round does not "cook off" and after weapon has cooled, has loader re-enter CEV and unload round	(C2101.8) 34.9b	Directs loader to place unfired round a safe distance from vehicle and all personnel (C2101.9) 38.11b
Loader		Bails out			Unloads round	Places round where directed
			38.8c		(C1101.6) 38.10c	(C1101.7) 38.12a
Driver		Bails out				
			38.8d			

Tank Commander		Announces, "Short, BOT" "Long, BOT"	40.1a			Announces, "Short" or "Over"	43.a	(C3304.2)	43.a	Correct deflection b. announcing direction 5 mils (e.g., "Left" or Right-3"	44.1a	(C3304.3)	44.1a
Gunner	Inures that round is properly marked, and BOT is notified for disposal of round	Announces, "Short, BOT" or "Long, BOT"	40.1b	Uses location of burst as BOT aiming point	41.1b	Repositions gun so that BOT aiming point is on target	41.2c	(C2305.4)	41.2c				
Loader	(C2101.10) 38.13b	(C2305.2)	40.1b	Reloads as described in 34.0 and announces "Up"	(C1103.1-8) 42.1-6c					Reloads gun as described in 34.0 & announces "Up"		(C1103.1-8)	45.1-6c
Driver													

Tank Commander		Correct elevation by announcing direction & meters (e.g., "Drop 50" or "add 100")	(C3304.4) 44.3a		Announces "short," "over", or "lost"	Commands, "Cease fire"	
Gunner	Receive change in de- flection in mils, reposition gun in deflection		(C3306.1) 44.2b	Receive change in range in meters if HE, reticle is being used & reposition gun so that center of target is at new range in sight reticle	(C3304.2) 46.1a Announces, "short", "over", or "lost"	(C3304.7) 47.1a	Observes hit on target and searches for undamaged portio
Loader					(C3306.2) 46.1b		49.1a
Driver							

Tank Commander		Sees target is destroyed and commands, "Cease Fire"				
		(C3304.7) 52.1a/53.1a				
Gunner	Adjusts aim so that aiming point is on undamaged portion of target 50.1b					
Loader	Reloads as described in 34.0 and announces "Up" (C11-3.1-8) 51.1-6c	Sets maingun safety switch to SAFE 53.2c				
Driver						

# Engage Targets W/Searchlight From Predetermined Positions



Conditions: A CEV has been assigned the mission of guarding a particular sector of responsibility to deny enemy the use of transportation routes (bridges, tunnels, roads, etc.) or concealment (buildings, etc.)

Tank Commander	Considers sector of responsibility, observation and fields of fire, and cover & concealment (C3202.1-3) 12.1a	Selects primary position, alternate positions, and secondary positions (C3202.4-6) 12.2b	Designates firing position to driver and designates route to firing position (C3203.1/2) 12.3a	When required, dismounts and guides vehicle into position using proper arm and hand signals (C3203.3/4) 12.5a	
Gunner					
Loader					
Driver			Maneuvers CEV to firing position (C1201.1/2) 12.4d	Selects hull down position and stops vehicle on most level ground available (C1201.3/4) 12.6d	

	Prepares sketch map of target area using military and map symbols	Selects reference point in coordination with gunner	Azimuth indicator is zeroed on reference point	Reference point is plotted on range card	Targets are identified on range card	Target deflection is recorded
Tank Commander	(C3201.1) 13.1a	(C3201.2) 13.2a	(C3201.3) 13.3a	(C3201.4) 13.4a	(C3201.5) 13.5a	(C3201.6) 13.6a
Gunner		Selects reference point in coordination with T.D.	Azimuth indicator is zeroed on reference point	Reference point is plotted on range card	Targets are identified on range card	Target deflection is recorded
		(C2201.1) 13.2b	(C2201.2) 13.3b	(C2201.3) 13.4b	(C2201.4) 13.5b	(C2201.5) 13.6b
Loader						
Driver						



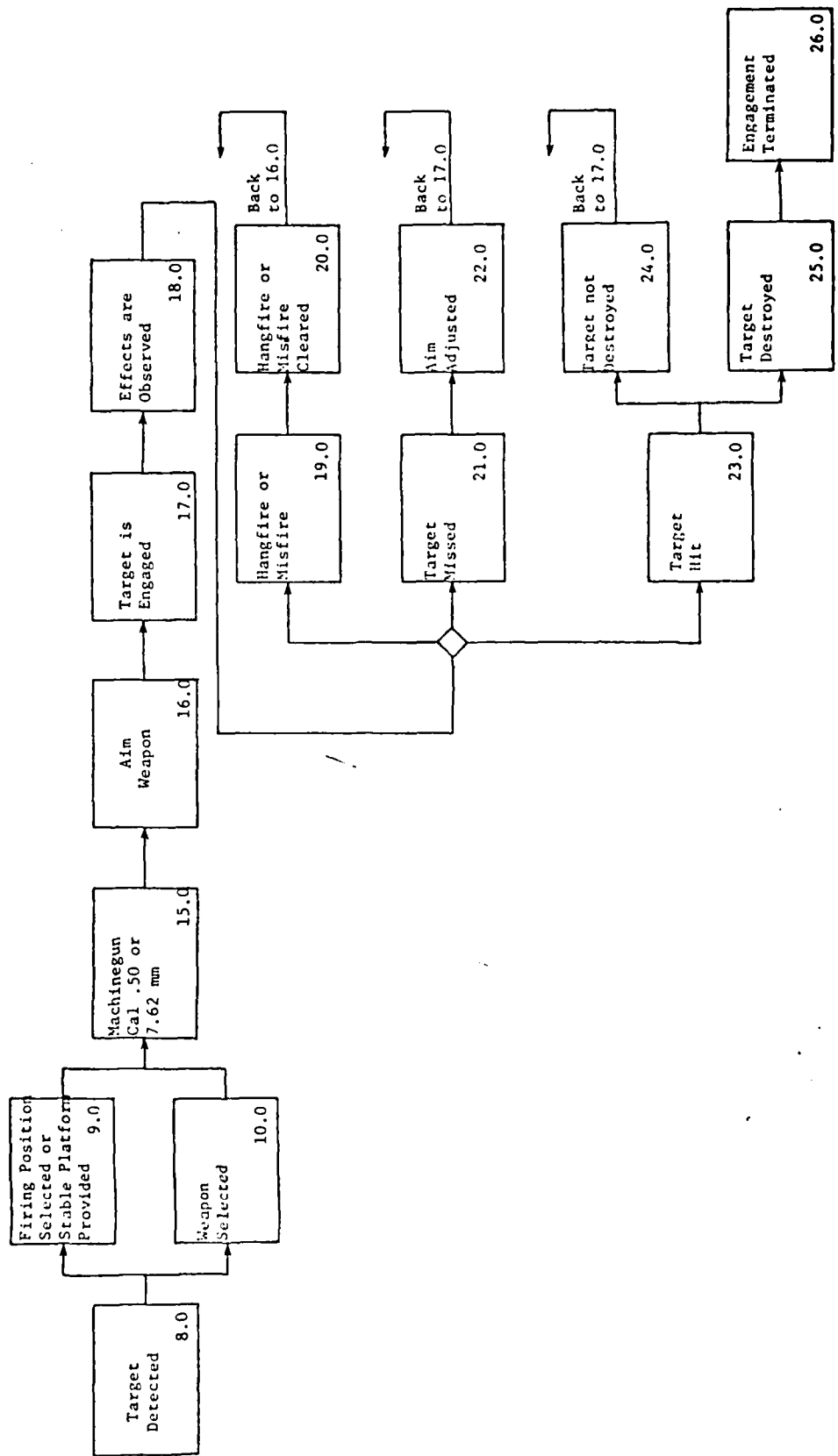
Tank Commander	Target range is recorded (C3201.7) 13.7a	Quadrant elevation for gun is recorded (C3201.8) 13.8a	Quadrant elevation for searchlight is recorded (C3201.9) / 13.9a	CEV's sector of responsibility is recorded (C3201.10) 13.10a	Marks range card for appropriate firing position (primary, alternate, secondary) 13.11a	Communicates w/ adjacent tank or CEV to determine target to be illuminated & type of illumination required (C3301.1) 14.1a
Gunner	Target range is recorded (C2201.6) 13.7b	Quadrant elevation for gun is recorded (C2201.7) / 13.8b	Quadrant elevation for searchlight is recorded (C2201.8) 13.9b	CEV's sector of responsibility is recorded (C2201.9) 13.10b	Marks range card for appropriate firing position (primary, alternate, secondary) (C2201.10) 13.11b	
Loader						
Driver						

Tank Commander	Identifies target on range card (C3303.1) 14.2a	Orders, "Gunner-White Light" or "Blacklight" depending on type required (C3303.2) 14.3a/27.1a		Determines target de- flection from range card and announces deflection to gunner (C3303.3) 28.2a		Verifies deflection read back by gunner (C3303.5) 28.4a
Gunner			Turns turret power to ON (C2303.1) 28.1a		Traverses to announced deflection, reads back deflection (C2303.2) 28.3b	
Loader						
Driver						

Tank Commander	Determines quadrant elevation from range card and announces to gunner (C3303.4) 28.5a		Verifies quadrant ele- vation read back by gunner (C3303.5) 28.7a	Sets controls on AN/USS-1 control box for desired illumina- tion (C3303.6) 29.1a	Orders "Fire" and turns on searchlight (C3303.7) 29.2a	
Gunner		Sets quadrant eleva- tion on quadrant, zeros bubble, reads back quadrant eleva- tion (C2303.3) 28.6b				Moves searchlight beam to center of target (C2303.4) 29.3b
Loader						
Driver						

Tank Commander	Calls adjustment of searchlight as needed (C3303.8) 30.1a	When adjacent vehicle completes firing, commands, "Cease Fire" and turns off search- light 31.1a			
Gunner	Adjusts aim of searchlight as directed by I.D. (C2303.5) 30.2b				
Loader					
Driver					

# Engage Aerial Targets w/Cal .50 Machinegun



Conditions: As crew in a CEV, unit or supported unit is under aerial attack, nearby air defense weapon engages target or target meets hostile criteria.

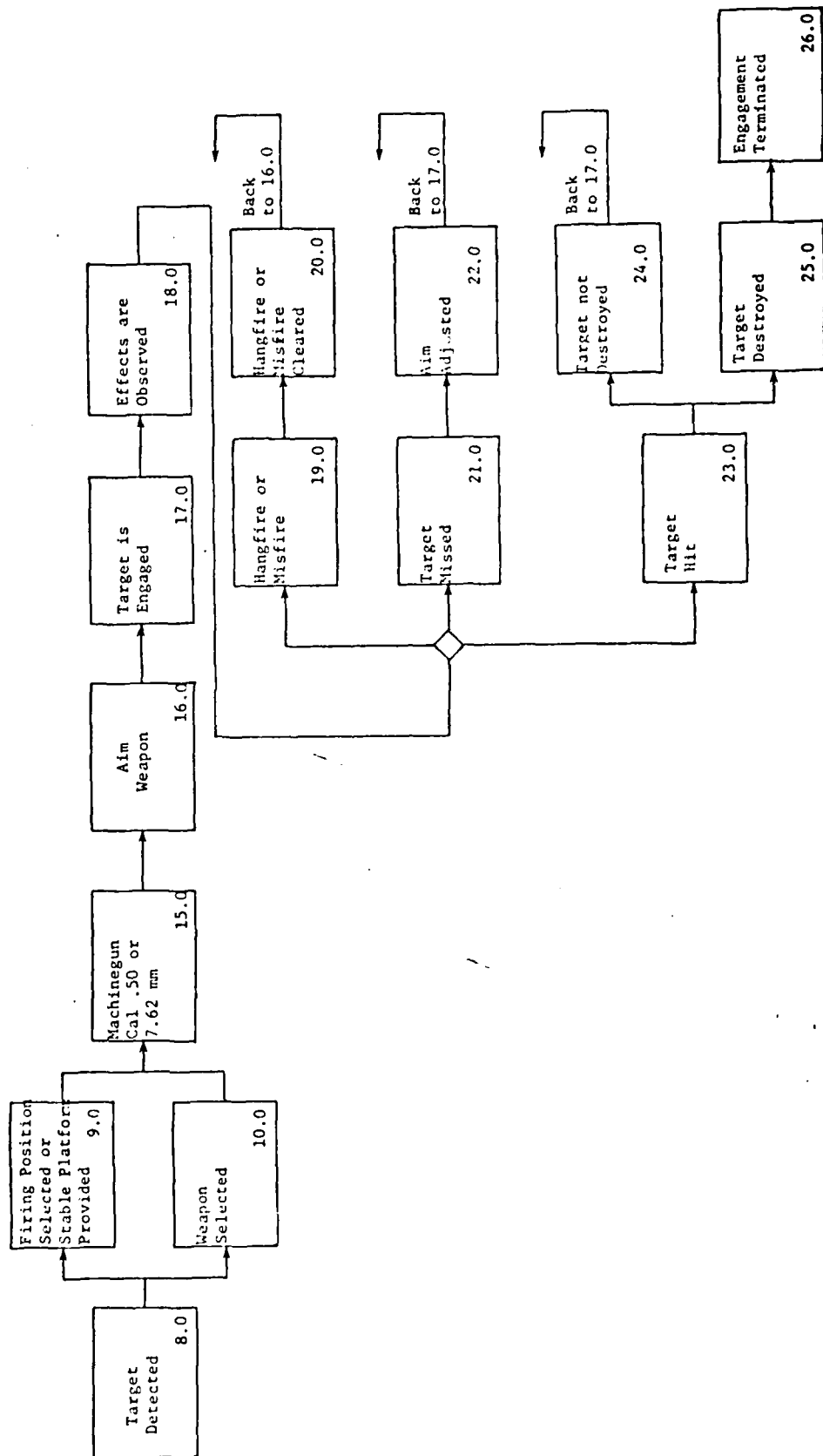
Tank Commander	Aerial target detected and identified as hostile	8.1a	(C3306.1) 10.1a/15.1a	Sets cupola power ON, safety switch to FIRE and rate switch to HIGH	10.2a (C3306.2)	16.1a/17.1a (C3306.3)	If weapon is cold; keep weapon trained to target, wait 5 seconds for possible hangfire	20.1a (C3102.1/2)	Retract bolt and press trigger	20.2a (C3102.3)
Gunner	Aerial target detected and identified as hostile	8.1b								
Loader	Aerial target detected and identified as hostile	8.1c								
Driver	Aerial target detected and identified as hostile	8.1d	9.1d	Stops CEV						

Tank Commander	If weapon fails to fire, wait another 5 seconds and retract bolt (C3102.4) 20.3a	Open cover and remove ammunition (C3102.5) 20.4a	Determine cause of stoppage, correct, reload, and continue engagement (C3102.6) 20.5a	OR If weapon is hot; wait 5 seconds for possible hangfire (C3102.7) 20.1a	Retract bolt and press trigger (C3102.8) 20.2a	If gun does not fir open cover and unlo ammunition within 5 seconds (C3102.9) 20.3a
Gunner						
Loader						
Driver						

Tank Commander	If gun cannot be un- loaded within 5 seconds, let bolt go forward, close cover and wait 15 minutes before reloading (C3102.10) 20.4a	If second stoppage occurs after clearing pro- cedures (C3102.11) 20.5a	If a third stoppage occurs, wait 5 seconds, unload gun and troubleshoot (C3102.12) 20.6a	Continue to reposi- tion and fire using cone of fire tech- nique until target is destroyed or out of range (C3306.4) 22.1a/24.1a	Announces "T.C. Complete," and places safety switch to SAFE (C3306.5/6) 26.1a	
Gunner						
Loader						
Driver						



# Engage Ground Targets w/Cal .50 Machinegun



Condition: As crew of a CEV, given a CEV ground targets appropriate for engagement with Cal .50 MG are encountered

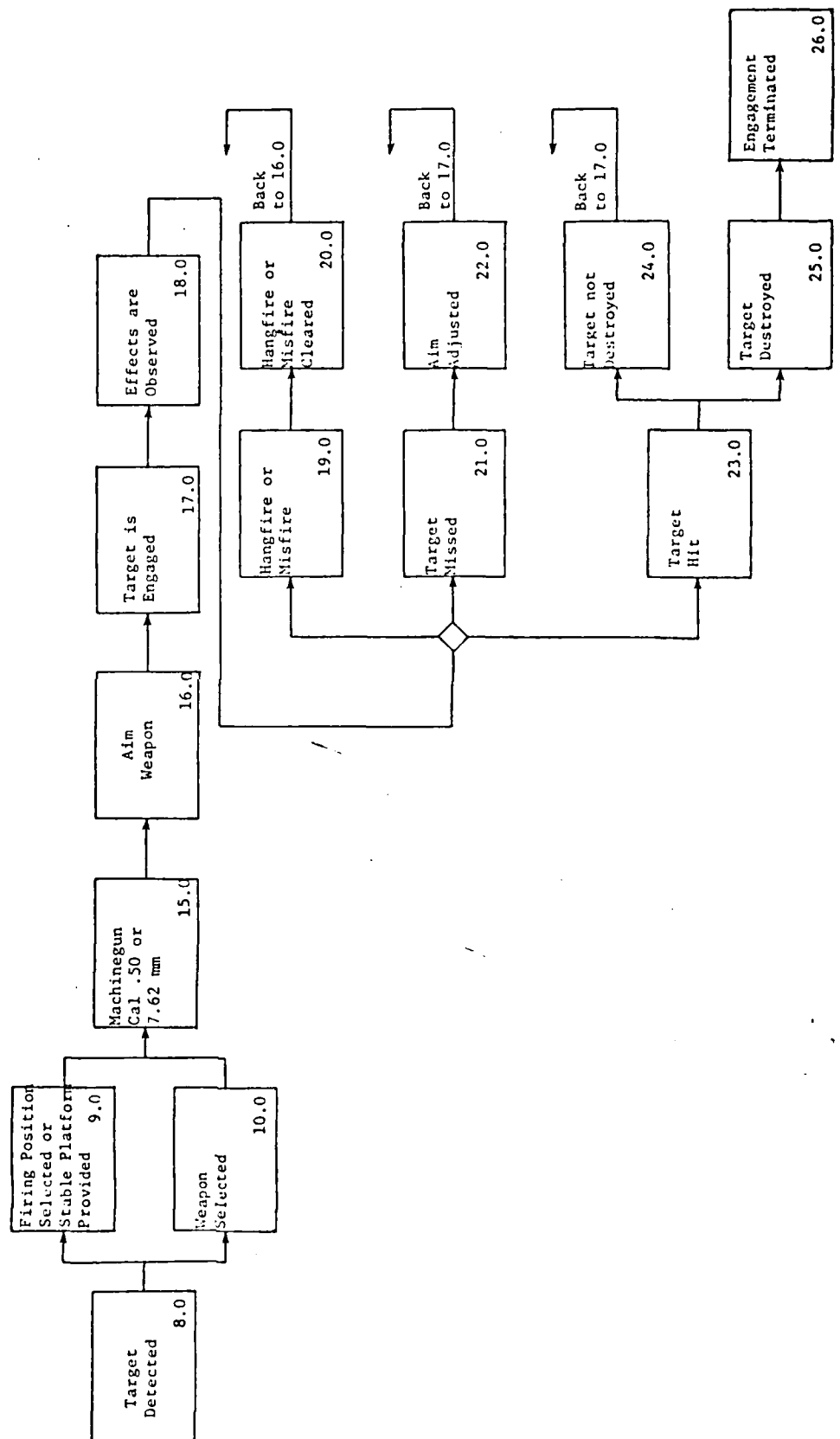
Tank Commander	Detects and identifies target	Announces "Cal .50"	Sets cupola power switch to "ON", safety to "FIRE", and rate of fire switch to "LOW"	Estimates target range and lays gun on that range line in M36 reticle, using azimuth and elevation controls for cupola	Fires 10 to 15 round bursts in low rate	If weapon is cold; keep weapon trained to target, wait 5 seconds for possible hangfire
Gunner	8.1a Detects and identifies target, informs T.C.	8.1a (C3305.1) 10.1a/15.1a	10.2a (C3305.2)	16.1a (C3305.4)	17.1a (C3305.4)	20.1a (C3102.1/2)
Loader	8.1b Detects and identifies target. Informs T.C.					
Driver	8.1c Detects and identifies target. Informs T.C.	8.1c	9.1d Slows or stops CEV depending on whether target is point or area type			

Tank Commander	Retract bolt and press trigger (C3102.3) 20.2a	If weapon fails to fire, wait another 5 seconds and retract bolt (C3102.4) 20.3a	Open cover and re- move ammunition (C3102.5) 20.4a	Determine cause of stoppage, correct, reload, and continue engagement (C3102.6) 20.5a	OR If weapon is hot; wait 5 seconds for possible hangfire (C3102.7) 20.1a	Retract bolt and press trigger (C3102.8) 20.2.
Gunner						
Loader						
Driver						

Tank Commander	If gun does not fire, open cover and unload ammunition within 5 seconds (C3102.9) 20.3a	If gun cannot be un- loaded within 5 seconds, let bolt go forward, close cover and wait 15 minutes before reloading (C3102.10) 20.4a	If second stoppage occurs after clearing, repeat clearing pro- cedures (C3102.11) 20.5a	If a third stoppage occurs, wait 5 seconds, unload gun and troubleshoot (C3102.12) 20.6a		Adjusts fire by "walking" tracers into target area (C3305.5) 22.2a
Gunner					Senses rounds, adjusts fire by calling "a little short", "a little to the right," etc. 22.1b	
Loader					Senses rounds, adjusts fire by calling "a little short", "a little to the right," etc. 22.1c	
Driver						

Tank Commander	Adjusts aim to continue destruction of target	Terminates engagement by announcing "I.C. complete" when target is destroyed or out of range	Places safety switch to "Off".			
	24.1a	7.1a (C3305.6)	7.2a (C3305.7)			

Engagement of Targets w/7.62mm Coax Machinegun



Conditions: As crew of a CEV, given a CEV, a target requiring engagement by the 7.62mm M6 is encountered.

Tank Commander	"Gunner-Coax-Truck-700u-Traverse right" (C2201.1,2,3,4,5) 8.1a/10.1a/15.1a/16.1a	"Driver, slow" or "Driver, take position at ____" 9.1a	Calls, "steady" as gunner closes on target (C3301.4) 16.3a		Calls "on" when gunner is aligned w/target (C3301.4) 16.5a	
Gunner	Sets turret power and machinegun switches to "0" (C2307.1) 15.1b	Traverses turret to right /		Slows rate of traverse 16.4b		Stops traverse of turret and says "identified" when target is sighted (C2307.2) 16.6b
Loader	Checks that turret ring is not obstructed (C1304.1) 15.1c	Checks that weapon is charged and ready & safety is in "Fire" position /	Insures the 3-4 inches of slack is between ammunition box and receiver (C1304.3) 15.3c	Announces "Up" (C1304.4) 15.4c		
Driver			Slows vehicle to provide a stable firing platform, or maneuvers smoothly into firing position selected by T.C. (C1303.2/3) 9.1d	Searches to detect target and other targets (C1303.4) 8.2d		

Tank Commander	Announces, "Fire at my command, ..." "Fire!" (C3301.7)	17.1a	Announces "On the way" and commences firing in 20-25 round bursts (C2307.5/6)	17.2b	Announces "Misfire" 19.1b	If gun is cold, waits 5 seconds (C1107.1)	Pulls back charging handle and pulls trigger (C1107.2)	20.1c	20.2c
Gunner	Sights target using M12C telescope w/H&P reticle. Estimates range & adjusts azimuth & elevation (C2307.3/4)	16.7b							
Loader									
Driver									



Tank Commander									
Gunner									
Loader	<p>If gun stops again, waits 5 seconds and unloads. Sets safety to "F", pulls charger handle to rear &amp; lets handle go forward slowly while pressing trigger (C1107.3) 20.3c</p>	<p>Loads gun and tries to fire manually. If gun stops again, waits 5 seconds, unloads and troubles-shoots (C1107.4) 20.4c</p>	<p>OR If gun is hot, waits 5 seconds (C1107.5) 20.1c</p>	<p>Pulls back charging handle and pulls trigger (C1107.5) 20.2c</p>	<p>If gun stops again, waits 5 seconds and tries to unload within 5 seconds (C1107.6) 20.3c</p>	<p>If gun cannot be unloaded within 5 seconds, lets bolt go forward, closes cover, and points gun in safe direction for 15 minutes to cool (C1107.7) 20.4c</p>			
Driver									

Tank Commander	Observes impact of rounds, adjusts fire by saying "up a little," "right a little," etc. (C3301.9) 22.1a			Commands "Cease fire" when target is destroyed or out of range (C3301.9) 26.1a	.	
Gunner		Alters aiming point based on commands of T.C. (C2307.7) 22.2b	Alters aiming point to continue destruction of target 24.1b		Stops firing. Turns machinegun switch to OFF (C2307.8) 26.2b	
Loader	Ensures that 3-4 inches of slack is maintained between the ammunition box and the receiver (C1304.4) 22.1c				Places weapon in "Safe" position (C1304.5) 26.2c	
Driver						

APPENDIX D

D-PAC COSTING GUIDE

## D-PAC COSTING GUIDELINE

### Introduction

The objective of the following costing guideline is to lead an analyst through a series of steps that will lead to an estimate of the cost of developing, acquiring, and operating a DORAC. Factors that are considered in estimating the total cost of the capability include the following:

1. Facilities--Physical assets (buildings, land, etc.) required for the implementation and support of a DORAC system.
2. Equipment--Hardware directly associated with evaluation positions and their support.
3. Materials--Software (user materials, films, texts, computer programs, etc.) necessary for the conduct and support of DORAC evaluations.
4. Personnel--Evaluator and evaluatee costs incurred as a *direct* result of DORAC evaluation activities (e.g., salaries, travel, per diem, expendable supplies, etc.).

The first step in costing a DORAC is to specify the exact nature of each alternative; that is, to list the devices required, the planned number of evaluations per year, and support requirements in terms of operators, evaluators, and maintenance personnel; and so forth. Then, for each training device comprising part of an alternative and for the baseline alternative, the following series of steps is completed:

#### Step 1. Compute Anticipated Facility Load (AFL)

- a. Specify Annual Evaluation Frequency (AEF), the number of times each evaluatee must be evaluated annually using the device.
- b. For the device, specify the Evaluation Cycle Size (ECS), the number of evaluation positions that can be used simultaneously.
- c. Identify Organization Evaluation Unit Size (OEUS), the evaluatee group size (e.g., individual, squad, platoon, company, etc.) organic to the base organization (e.g., battalion, brigade, division, post, etc.) that most closely matches, without exceeding, the ECS.

- d. Specify the number of Evaluatees per Organization (E/O), the total number of personnel within the base organization that the evaluation is applicable to.
- e. Compute Organizational Evaluations (OE), the number of evaluation cycles required to process one base organization:

$$OE = \frac{E/O}{OEUS} \quad (A-1)$$

- f. Compute Base Facility Load (BFL), the number of evaluations required to put all relevant base organizations ( $N_{org}$ ) through one evaluation cycle:

$$BFL = N_{org} \times OE, \quad (A-2)$$

where  $N_{org}$  is the number of base organizations scheduled to undergo evaluation.

- g. Compute Estimated Facility Load (EFL), the expected number of evaluation cycles to process all base organizations on all evaluations:

$$EFL = BFL \times AEF. \quad (A-3)$$

- h. Determine the expected number of re-evaluation (RE) cycles:

$$RE = PLE \times EFL, \quad (A-4)$$

where PLE is the estimated percentage of lost evaluations.

- i. Finally, compute AFL, the expected number of evaluation cycles required to process all evaluatees, plus expected re-evaluations:

$$AFL = RE + EFL. \quad (A-5)$$

## Step 2. Compute Device Capability (DC)

- a. Determine Work Segment Length (WSL), the length of time in hours between work starts and stops during the work day.
- b. Specify the Number of Work Segments (NWS), the number of WSL periods per work day.

- c. Estimate Evaluation Cycle Length (ECL), the anticipated time in hours required to conduct one evaluation cycle using the device.
- d. Estimate Time Between Cycles (TBC), time in hours spent in orientation briefing, data collection, or critique.
- e. Compute the number of Evaluation Cycles per Day (EC/D) (rounded to nearest integer):

$$EC/D = \frac{WSI \times SN}{ECL + TBC} \quad (A-6)$$

- f. Estimate Time Device Available (TDA), the number of training days per year the device is expected to be operational (round to nearest day):

$$TDA = PTA \times TDY, \quad (A-7)$$

where PTA is the percentage of time the device is expected to be available,

and TDY is the number of training days per year.

- g. Compute Device Capability (DC), the expected number of evaluation cycles per year that one device will accommodate:

$$DC = TDA \times (EC/D). \quad (A-8)$$

### Step 3. Compute the Number of Devices Required (NDR):

$$NDR = AFL/DC. \quad (A-9)$$

### Step 4. Determine Incremental Acquisition Cost of Device (ACD)

- a. Compute Device Hardware Cost (DHC), the cost of acquiring the required number of devices (above the number required solely for training):

$$DHC = (NDR - NDOH) \times UCD, \quad (A-10)$$

where NDOH is the number of devices on hand for training purposes,

and UCD is the unit cost of the device.

- b. Determine Direct Personnel Costs (DPC). DPC is the sum of the estimated number by proposed pay grade of operators, evaluators, and maintenance personnel multiplied by their salaries and benefits. Again, this is the incremental cost associated with providing personnel for purely evaluation purposes.

- c. Determine evaluation-related Personnel Training Costs (PTC):

$$PTC = CIT + EFT, \quad (A-11)$$

where CIT is the cost of initial training for operators, evaluators, and maintainers;

and EFT is the expected cost of follow-on training (if any) plus the cost of training replacements for the initial cadre.

- d. Compute Administrative Operating Costs (AOC):

$$AOC = EXS + TC, \quad (A-12)$$

where EXS is the cost of data recording supplies, office supplies, facilities supplies, equipment supplies, utilities, ammunition, targets, and so forth associated with evaluation activities,

and TC is the cost of any required travel for evaluatees or cadre (again, evaluation related).

- e. Estimate Facilities Cost (FC). FC is the total cost of required acquisition, construction, or modification for device-related facilities used solely for evaluation.

- f. Estimate Annual Maintenance Cost (AMC), the annual cost of maintaining device-related facilities used solely for evaluation.

- g. Compute ACD:

$$ACD = DHC + (DPC + AOC + AMC) \times EY + PTC + FC, \quad (A-13)$$

where EY is the expected life of the device.

Step 5. Determine Total Device Cost (TDC):

$$TDC = ACD + EEIR \times DHC \times EY, \quad (A-14)$$

where EEIR is the expected replacement rate (percentage) per year for end item equipment used for evaluation purposes.

Step 6. Determine Total Estimated Cost of Alternative (TECA):

After the estimated cost of each device constituting a DORAC alternative is calculated, these costs are summed to produce the Total Estimated Cost of the Alternative (TECA):

$$TECA = \sum_{i=1}^{NDEV} TDC_i, \quad (A-15)$$

where NDEV is the number of individual devices constituting DORAC alternative  $i$ ,  
and  $TDC_i$  is the estimated cost of the  $i^{th}$  device (from A-14).

The application of (A-15) in determining the total estimated cost of alternative  $i$  makes the assumption that all individual device costs are mutually exclusive; that is, no shared costs (e.g., common operators, evaluators, facilities, etc.) are involved. In the event that shared costs are involved, assign the overlapping costs to one device. In this manner, shared costs are only counted one time.